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THE PROBLEM OF ORGANIZATION

THE PROBLEM

THE contemplation of living beings has ever plunged the human mind into a state of perplexity and interrogation. So manifold are the aspects presented to us by the form and behavior of living things and so diverse are the minds which have sought to interpret the phenomena of life that we may at times feel ourselves submerged in a sea of distracting problems, uncorrelated theories and data which, while valuable, are more or less chaotic. From time to time, momentarily realizing that the particular problem which looms immediately before us, mighty and impregnable, is but one of a score or a hundred of equal importance, and that its solution would be for us as merely one sentence of a long story, we give vent to a question which at once epitomizes all of our perplexities and expresses the very heart of what we want to know. We ask, what is an organism? But this question, simple in form, yet all-inclusive, leads us nowhere. It is a blank wall offering no foothold for experimental attack. Should nature present to us no other question than this, she will ever remain a sphinx. For working purposes we must find questions which suggest a program of investigation. The following discussion states no new problem. Nor does it purport to be in any essential matter a new statement of the old problem of the organism. It is at most a restatement of the problem in terms which lay the emphasis at a point where it has been, perhaps, not so commonly put, but where for purposes of investigation I believe it may

to advantage be placed. We will ask, not "what is an organism," but *what is organization?* The first question is too comprehensive and therefore vague and unworkable. The latter question, aiming at the very essence of what we want to know, enables us to turn from the distracting complexity of the entire organism to any observable part of it, the smaller and simpler the better, which exhibits that distinctive characteristic of the whole, *organization.*

A familiar form of anatomical description begins by stating that the morphological unit is the cell. Cells, then, are associated together to form tissues, which enter into the composition of organs. Several organs cooperating in a set of related functions constitute an organ-system. The whole animal, finally, may consist of several such organ-systems. A complete description of structure would lead us to a considerably greater degree of complexity, for we should find units intermediate between certain of those which we have just mentioned. Thus, the kidney as a whole we call an organ. But analysis resolves it, not immediately into tissues, but first into such secondary or lesser organs as renal tubules, renal corpuscles and blood-vessels.

Turning from the morphological to the physiological point of view, we observe a series of units of function precisely corresponding to the series of structural units. It could not be otherwise, for structure is merely the visible expression of function.

Whether we view the structural or the functional aspect of the animal, we see the component units so correlated and coordinated one with another that the result is a harmonious action of the whole in relation to a fairly well-defined set of external conditions. This systematizing of many lesser units into one greater unit is so striking a peculiarity of living things that we call them organisms.

Organization, however, is a peculiarity not merely of the animal or plant as a whole, but likewise, to a considerable degree of minuteness, of its constituent structural units. There are certain things which cells do quite independently of the fact that they belong to any particular tissue or animal. The fundamental processes of metabolism, growth and reproduction are inherent in cells. Obviously, a tissue cell has an organization within itself. So far as my present purpose is concerned, it would not now be profitable to speculate as to how far there may be still other self-contained organizations within and inferior to the cell. A tissue, likewise, has a certain organization within itself. There are certain activities which a tissue performs quite independently of the fact that it is a part of a particular organ or animal. Muscle tissue, removed under appropriate experimental conditions from the animal to which it belongs, exhibits its characteristic activities. The contraction of an excised piece of muscle is, to be sure, merely the resultant of the contractions of its constituent cells. I speak of it as a tissue act rather than a cell act in the sense that it is action of a specialized type—one not exhibited by cells in general but only by such cells as possess those peculiarities characteristic of muscle tissue. A small bit of epithelium transplanted into a foreign locality, or maintained under artificial cultural conditions, may exhibit its peculiar habits of growth. The essential function of an epidermis is to cover outside surface. If a portion of an animal is denuded of epidermis, the remaining epidermis, provided the wound is not too extensive, extends over and covers the exposed deeper tissues. If a small fragment of living ani-

mal material, including some epidermis together with deeper tissue, is isolated under proper conditions, the fragment may become more or less completely covered over by extension of the epidermis. This covering of outside surface by epidermis of uniform thickness and character is distinctly a tissue phenomenon due to a certain organization inherent in the tissue. It is not dependent, at least not necessarily dependent, upon the organization of the animal as a whole. A distinction between tissues and organs can not always be sharply made. However, it is clear that the action of an organ is not necessarily dependent upon the integrity of the animal to which it belongs. A vertebrate heart, under proper conditions of temperature and fluids, will continue its rhythmic action long after removal from the animal. (So, indeed, will an excised strip of its muscular wall.) An excised kidney long retains the capacity for functional activity. Under normal circumstances it is dependent for its oxygen and nutrition upon the animal to which it belongs. But in its organization as a kidney, it seems to be quite independent of the animal as a whole. And finally, there are activities which are distinctly functions of the animal as a whole—the hydra seizing and swallowing a cyclops, a dog following a scent, a cat fighting, a kitten playing. Here we see the animal acting as a unit. Its action is relatively simple and intelligible just as its external form is. But analysis of the action resolves it into a complex of physiological units corresponding to a complex of structures involving perhaps all of the subordinate organizations of the animal.

Comparing the units of these several grades of organization, the cell stands forth with peculiar prominence. It has always appeared so to the biological mind. The fact that every animal part, upon analysis, reduces to cells, the uniformity in size and visible structure of these bodies, make them conspicuous as universal morphological units. The tissue, and even the organ, is ordinarily much less definitely formed and limited, less sharply individualized. The organ-system is obviously a somewhat arbitrarily distinguished unit. In strict morphological sense, at the first step of analysis the whole individual resolves itself directly into organs. The natural tendency, then, is to regard the cell as the essential morphological and physiological unit. In fact, so important does the cell appear that we have been inclined to consider the relation between cell and organ, or even between the cell and the whole individual, to be a direct one rather than one which is indirect by way of such intermediate systems as may exist.

In presenting this familiar sketch of the plan of an organism, I use the word, organization, in its ordinary sense. It is not structure nor is it function. It consists in certain definite and obvious relations of functions, and therefore of structures too. It asserts nothing as to the nature of these relations and it implies nothing as to how they have come to exist. Just here we meet some serious biological problems. What is the nature of those relations which constitute organization? How do they come into being? By what and how is it determined that a group of cells shall be associated together to constitute an epithelium of definite and constant thickness and character? In muscle tissue how does it come about that thousands of cells are substantially alike and capable of operating harmoniously together in response to an effect received from nerves? What is it that affects a mass of tissue of a certain kind in such a way that it assumes the

form and position appropriate to its participation in the tissue complex of an organ? What determines those mutual relations whereby diverse organs operate harmoniously together in the service of the whole?

Our conception of the organization of living things must remain imperfect and incomplete until such questions as these are answered. When they have been answered we may, in the light of our increased knowledge, amplify and perfect our definition of the word, organization. Or, if we prefer, the word may be retained in its present significance as applied to plants and animals, indicating those relations which even now we clearly enough perceive to exist, and we may use some other designation for whatever shall have been found to underlie these relations. I am using the word to designate those conspicuous peculiarities which have led us to call living things organisms. Our problem is to discover upon what this organization rests.

HYPOTHESES

The inquiry as to the nature and underlying basis of the relations which constitute organization meets two alternative answers. According to the one we may regard the constituent elements of any organic system—be it cell, tissue, organ, or the whole individual—as causally independent of one another *so far as their condition of being organized into a system is concerned,* and we may suppose further that no dynamic agent specifically responsible for their organization into a system exists. The fact that the constituent elements of the system do depend upon one another in a variety of ways and that they do stand in diverse definite relations to one another constitutes their organization. But the cause of the organization of the system does not necessarily lie within the various interrelations of the several members of the system, nor in any effects derived from other organic systems. Each element possesses a certain constitution. It exists in a certain physical, that is, nonphysiological, environment. (The physical peculiarities of this environment may, however, be to a great extent dependent upon the physiological operation of other organic elements and systems.) It executes activities which are direct functions of its constitution and environment. If these activities take place in such a way as to produce harmonious action of the several members of a group, thus constituting them into a system, such harmony is to be regarded as merely the incidental result of the circumstance that the members are so constituted and so environed. The member is in no way responsible for the fact that its behavior is subserving the needs of the entire organism, and no more is the organism as a whole responsible for the behavior of its elements.

Viewed in this way, the organization of any system results essentially from peculiarities in the constitution of the members of that system, the members being not only independent of one another as regards the fact of their being organized, but likewise independent of any immediately present coordinating agent. Organization, then, is merely something that we read into natural phenomena. It is in itself nothing. Going to the logical conclusions of the matter, it is a name for certain inevitable and purely accidental consequences of the circumstance that atoms or other primordial physical entities possess certain inflexible habits of movement. If we are perplexed by the fact that the total effect of the operation of a subordinate system appears as a more or less important function in the

physiological economy of the whole animal, we need only consider that, had it been otherwise, the "struggle for existence" must have long since made an end of the matter.

An alternative view attributes the harmonious operation of a system to the action of some dynamic agent or energetic complex which exercises general control over the members of the system. These members must be similarly constituted in order that they may properly respond to the controlling agent. The control may be conceived to consist in the action of a superior dynamic agent upon an inferior system, or in some effect of the system as a whole upon its individual members.

It is quite obvious that the activity of one organ does affect the tissues and cells of other organs and that the units of one system are dependent in a variety of ways upon other systems. An epidermal cell is dependent upon the digestive, respiratory, circulatory and excretory systems, and less directly upon the nervous and other systems. There are numerous other relations, perhaps equally important even if less obvious, such as exist between the ductless glands and other organs and tissues in vertebrates. Indeed, it appears likely that we are at present very far from a complete knowledge of the extent to which internal secretions or hormones may serve in the correlations of organs. In ontogeny hormone action may play a rôle of utmost importance as a "mechanism for organic correlation."[1] The nervous control of muscular, secretory and other activities affords what is, in a sense, the most conspicuous instance of control exerted by one part over another part. But while such relations as those involved in nervous control and hormone action may be absolutely essential to the normal operation of the various organs and systems of the animal, it by no means necessarily follows that such relations involve any *general control* of the *organization* of the elements of one organ by the action of another organ. So far as the nervous system is concerned, quite the reverse may be true. An agent which controls certain activities of a group of elements may in no way be responsible for the fact that those elements are capable of responding to its control. The relation of the nervous tissue to the muscle tissue may be exceedingly limited in that it is perhaps only the processes concerned with contracting that are under nervous control. The general organization of the muscle is not, so far as we know, due to nervous control. Professor R. G. Harrison and his co-workers have achieved results of far-reaching importance in demonstrating that the ontogenetic differentiation of muscle tissue is independent of any action of the nervous system. In the fully differentiated muscle tissue exists an organization which renders the tissue capable at any instant of proper response to nervous stimulation. What is it that maintains this organization in the muscle? An answer to the question may be offered by asserting that the histological peculiarities of muscle tissue are due to germinal preformation, and having been so determined and developed, they persist. This may or may not be satisfying. Tissue cells are not structures like stone blocks laboriously carved and immovably cemented in place. They are rather like local eddies in an ever-flowing and ever-changing stream of fluids. Substance which was at one moment a part of the cell passes out and new substance enters. What is it that prevents the local whirl in this unstable stream from

[1] Parker, G. H., 1909, "A Mechanism for Organic Correlation," *American Naturalist*, Vol. 43, April, pp. 212–218.

changing its form? How is it that a million muscle cells remain alike, collectively ready to respond to a nerve impulse? If germinal preformation answers the question, the nervous system is relieved of any responsibility for the maintenance of organization in the muscle tissue. The nervous system exercises occasional instantaneous effects upon the muscle, resulting in one particular kind of activity. So far as this relation is concerned, there is no evidence of general control exerted by nervous tissue over muscle tissue. Even the more or less continuous tonic effect of nerve on muscle does not prove the existence of any control beyond the observable tonic effect itself.

With the case of internal secretions the matter stands much the same. That a substance poured by one gland or tissue of the body into the blood stream may produce most important and specific effects upon other tissues or organs has been demonstrated beyond doubt. The secreted substance may be one in whose absence certain definite abnormal conditions arise, as in the case of the thyroid. Or it may be one whose presence is somehow connected with the perfectly normal development of an organ, as in the relation between gonads and secondary sexual organs. But in all these relations which are established by the transmission of nervous impulses or specific substances from one part of the body to another, we find no answer to the question which we have stated. Upon the contrary, the more of these relations we discover, the more intricate does our problem become, for it is precisely these relations which constitute organization. They are the materials of our problem, not evidence toward its solution.

Any one of these relations is open to either of the two interpretations which I have stated. View the animal, if possible, without the prejudice which arises from the knowledge that it is an organism. View it as if it were a non-living dynamic complex. The nervous system at once loses its paramount importance. It appears as a system coordinate with several other systems. It no more controls other systems than it is controlled by them. True, certain conspicuous events in muscle are conditioned by something that happens in nervous material. But, so far as we can clearly see, it may be equally true that every operation and event in the nervous tissue is conditioned more or less directly by activities going on in other systems or otherwise outside of the nervous system. The nervous tissue appears as a group of elementary organisms of peculiar form, existing in an environment in which they find the materials requisite for their maintenance. They receive more or less intermittent influxes of energy from this environment and, in turn, discharge it in a more or less modified form. In muscle tissue we see another group of elementary beings, muscle cells, whose habitual environment subjects them to certain energetic actions to which they exhibit a fixed type of reaction. And so it is throughout the whole organism. The substance or the energy which is given off by one element as a by-product or a waste product of its activities becomes a peculiarity of the environment in which other elements habitually carry on their existence. It is a vast symbiosis. It is comparable to the relation which exists between the plant life and the animal life of the globe. Green plants need carbon dioxide and give off oxygen. Animals need oxygen and give off carbon dioxide. And so they live successfully together. But would any one venture to propose that the internal organization of

animals is determined and controlled by plants, or that of plants by animals? There is no more ground for asserting that the organization within a subordinate organ of the individual plant or animal is determined and controlled by another organ from which the first receives some form of energy or some substance. It is clear that the secretion of the thyroid affects the integument. In the absence of that secretion the integument becomes altered in character. But it does not become disorganized. Its cellular elements remain organized as integumentary tissue, but with changes in the details of that organization. There is no ground for attributing the fundamental fact that certain cells are organized as integumentary cells to the influence of the thyroid secretion or any other secretion contained in the body fluids.

The whole process of organic development may possibly be described in terms of hormones. If that shall come to pass, a considerable degree of complication will have been added to our conception of the process of ontogeny and our information will have been vastly enlarged. May such an achievement be regarded as bringing us one step nearer our goal of understanding the nature of the organization upon which development rests? Only in the sense that it is one step of an infinite number of steps of that particular kind which separate us from the goal. To discover a mechanics of development in terms of hormones is to bring within our cognizance additional facts of organization. No such description will reveal to us the essence of organization. I do not mean to discredit the search for mechanism. Just so far as mechanism exists we must know about it, for we seek the complete truth about organisms. It is conceivable that practical benefits of inestimable importance may follow from a complete knowledge of organic mechanism. But the nature and origin of mechanism are not to be found by discovering more mechanism.

It appears possible that the development of the lens of the vertebrate eye depends upon some effect proceeding from the optic vesicle. But even if this relation is fully proved, the problem of the development of the lens is by no means solved. The invagination of the ectoderm to form a lens may depend upon contact of the optic vesicle with the ectoderm, or upon the action of a substance given off by the optic vesicle. Any such relation between the two structures is open to either of the two interpretations which are before us. The invagination of the lens ectoderm involves what looks to us like concerted action upon the part of numerous cells. We may suppose that each cell possesses an inherent mechanism which, under the conditions in which the cell normally finds itself, compels the cell to play just that particular part in lens development which it does play. This inherent mechanism depends, we may suppose further, upon germinal preformation which in the last analysis, if this view is carried to its logical consequences, depends upon chance combinations of atoms and the accidents of selection. It is a peculiarity of the environment in which the cells live that at a certain time an effect is produced upon them by a group of underlying cells (assuming the relation between the optic vesicle and the lens to have been proved). It happens that this effect introduces precisely the conditions needed to set going the separate mechanisms in the several cells. Upon this view the organization within the ectodermal layer—its organization as ectoderm and such more or less localized organization within it as renders

it capable of producing lenses—is in no way determined by the action of the optic vesicle. The effect proceeding from the optic vesicle serves merely as the trigger to set off the separate mechanisms of the superficial cells. We may conceive the cells, then, to be absolutely independent of one another in the matter of lens formation. Their concerted action is the purely accidental result of the fact that they suffered simultaneously a change in their environment, that is, the effect derived from the optic cup. This effect merely initiates the development of the lens. Neither the ectodermal organization which causes that development nor the process of development is determined by the optic vesicle. Even if lens development required the continuous action of an effect from the optic vesicle, this view of the relation need in no wise be altered, for that continuous action would constitute merely a persistent feature of the environment appropriate to the operation of the separate mechanisms of the ectodermal cells. It is possible, as some experimental data seem to indicate, that regions of ectoderm remote from those which normally give rise to lenses are capable of producing lenses as a result of the action of transplanted optic vesicles.[2] If this is true, the fact would seem to put considerable strain upon the view just outlined. Nevertheless, it is always possible to buttress up a favorite hypothesis with subsidiary hypotheses. If the main thesis is highly esteemed, often some very complicated accessory hypotheses will be tolerated. I am sure that any such difficulty as the present one—and the experimental work upon embryos has yielded many such—will readily yield to this treatment. I will leave the task for those to whom this conception of organization is the favorite one.

What other interpretation can be put upon this matter of lens formation? The essential feature of the process is the concerted action of ectoderm cells. We may regard this concerted action as due to an agent which immediately exercises general control over the behavior of all the cells concerned. If it is true that the optic vesicle has something to do with the invagination of the lens, it is conceivable that the substance of the optic vesicle is a seat of energy which is somehow brought to bear upon the near superficial ectoderm, with the result that its cells are compelled to execute those changes of form and relative position which are involved in the shaping of a lens. We should have to attribute to the ectoderm cells similarity of structure and an inherent mechanism sufficient to render them capable of responding to the control of the optic vesicle. The expression "concerted action of ectoderm cells" should not convey the impression that every cell behaves precisely like every other. Obviously such can not be the case. The lens invagination is not exactly hemispherical. The changes in form and position of the cells must vary according as whether the cells come to lie nearer the axis or nearer the periphery of the invagination. Upon the first view which we have outlined, the factors which determine the differences in the behavior of the individual cells are contained within the mechanisms of the independently acting cells themselves. Upon the second view, which we are now presenting, the differential factors of lens formation lie outside the group of lens cells. So far as internal conditions are concerned, those cells may be precisely alike.

[2] Lewis, W. H., 1904, "Experimental Studies on the Development of the Eye in Amphibia," *American Journal of Anatomy*, Vol. 3, No. 4, pp. 505–536. See also later papers by the same author.

Upon the first, then, of our two views of lens formation, the lens is determined from within; upon the second view it is determined from without. By the first view we see the lens arising as, in strict sense, a purely accidental resultant effect of the operation of many mechanisms which are essentially independent of one another and independent of any external factor which compels their harmonious behavior. By the second view we conceive of an energy or energy-complex, situated perhaps in the substance of the optic vesicle, exerting itself upon a group of ectoderm cells and thereby coercing them into lens formation. In this case the ectoderm cells may be essentially alike and independent of one another, but they are collectively dependent upon an external controlling agent. The external energy-complex plus suitable ectoderm constitutes the formula for a lens. By transplanting the optic vesicle the first member of the formula may be brought into relation with a region of superficial ectoderm remote from that which normally gives rise to a lens. A lens must result there, as elsewhere, provided that the ectoderm in the newly affected region is not too unlike the normal lens ectoderm.

A group of particles of iron in a magnetic field assumes an orderly configuration under the influence of that field. A rough analogy exists between this phenomenon and the hypothetical relation between a group of ectoderm cells and a lens-determining force-complex originating in the optic vesicle or elsewhere. If, however, we succeed in imagining that each particle, in virtue of certain inherent peculiarities and independently of any agent which immediately controls the behavior of the particles collectively, assumes a certain position, and if we can imagine further that, as the outcome of a chain of entirely fortuitous circumstances in the past history of the particles, their several positions are such as to give the whole group an orderly configuration, we shall have illustrated our first conception of the nature of organization. Another illustration presents itself employing, instead of iron particles, mechanisms of considerable complexity and in so far offering greater similarity to what we see in plants and animals. Suppose that ten clocks, precisely alike in construction, strike the hours in unison. So long as the clocks are similarly affected by temperature, moisture and other external conditions, and so long as their energy holds out, they will continue striking the hours in unison—a tissue of clocks. We can imagine that the air vibrations produced by the striking serve to set off some other mechanism. But the mechanism of each clock is entirely independent of that of all the others. Further, so far as the several clocks themselves are concerned, there is no connection whatever between their striking and the setting off of some other mechanism. The air vibrations (a hormone) which transmit the effect from the clocks are something outside of and distinct from the clocks themselves and the responding mechanism as well. A human observer, noting that the clocks keep the same time and strike in unison, and noting that the initiation of a certain activity in another mechanism depends upon something that the clocks do, applies to these several relations the name, organization.

To illustrate the other conception of organization, we may suppose each of the ten clocks to contain a striking mechanism which, for its operation, requires that the clocks shall be affected by an electro-magnetic field. The clocks do not strike at all, then, until by the action of agents outside of themselves they come within the influ-

ence of such a field. They then strike in unison. We may even suppose that there exists a regulatory arrangement such that, if some clocks are running slow and others fast, the mechanism involved in striking serves automatically to restore the clocks to synchronous action. In this latter illustration the striking of the clocks depends in part upon their like construction. But the action of an electro-magnetic field is another and an essential factor in their concerted behavior. It is an agent entirely outside of the clocks themselves which exercises a general control over their activities.

In the first illustration of the clocks the striking in unison consists, so far as we can see at the moment, in the coincident acts of ten absolutely independent and self-contained mechanisms. In the second case there is immediately present a specific coordinating agent which compels the several mechanisms to united and harmonious action. In the absence of this agent the ten clocks would not strike together—they would not strike at all—nor would they keep time together. Viewing such a group of objects, we should see merely ten distinct mechanisms lacking any coordination into a unit or a whole. These illustrations hold only if not examined below the surface. Any inquiry as to how and why the clocks came to be constructed as they are and, in the first illustration, to be wound up, set together, and so precisely regulated as to keep time exactly together, will greatly complicate matters and will render the appropriateness of the illustration more or less dubious.

In this conception of organization as being dependent upon an agent which exercises general control over the elements which are organized, we are not limited to the idea that the control operates from without the group of elements. In the case of the lens we may equally well imagine that the controlling agent is in the lens ectoderm itself; not, however, as embodied in the separate mechanisms of the several cells, but as something which transcends cell mechanism, pervading, so to speak, the whole region of lens ectoderm. Upon this view a formative effect exerted by the optic vesicle upon the lens may be supposed to consist in a stimulus—merely a signal—which serves to initiate the action of a lens-determining agent in the superficial ectoderm. The development of a lens at places other than where a lens normally develops obviously presents difficulties to this hypothesis. We may think of this internal lens-determining agent as operating either by effects upon the individual cells or by action upon the ectodermal protoplasmic sheet as a whole, regardless of cells. Whitman, in 1893, in his paper on "The Inadequacy of the Cell-Theory of Development"[3] gave us a vivid picture of living substance developing into organic form through the operation of large force complexes which express themselves in thickenings, foldings, and the great variety of form changes seen in embryonic layers, irrespective of the subdivision of these layers into cells. At the present time there is a distinct tendency away from any such broad and relatively simple conception of developmental processes toward those which involve overwhelming multiplicity of determining factors and indefinite minuteness of structural mechanism. The current hypotheses which have had their inception in the Mendelian discovery and in correlated cytological research tend toward exaltation of the importance of the cell and more particularly of the chromosome, if not of yet more minute and less accessible elements into which the chromosome is hopefully to be shattered. Yet I believe that the status of the

[3] *Journal of Morphology*, Vol. 8, pp. 639–658.

chromosome is neither biologically nor philosophically so secure as to warrant us in contemptuously rejecting any hypothesis which fails to bow to the chromosome as the omnipotent ruler of organic form.

The first of our alternative views of organization attributes such harmonious and concerted action as we frequently see within a group of similar structural elements—for example, in a simple epithelium consisting of numerous cells which are structurally and functionally alike—to homogeneity in that complex of factors, internal and external, which affects the several members of the system, one factor being as essential as another, and no one factor being especially responsible for the concerted action exhibited within the system. If any one of these factors be removed, provided that it be not one which is directly essential to the existence of the system, the system immediately affected becomes no less organized, but merely undergoes some change in its organization. This change may be one which interferes with the operation of some larger system and perhaps results in the downfall of the whole organism. In such a disaster we see the selective action of "Nature" tending toward the firmer establishment of harmoniously and advantageously operating systems. A certain condition may be essential to the existence of a system, yet in no way responsible for the peculiarities of that system. Oxygen is essential to the existence of a dog, but oxygen is not responsible for the fact that certain living substance is organized as a dog and not as a cat.

In general, then, the first alternative asserts that organized form arises ontogenetically, and is maintained, by the operation of a multiplicity of factors which, for each particular of that form, are coordinate in rank and are associated together just as they are, not by any immediately present and directly operative necessity, but only indirectly through those several necessities which have arisen from circumstances in the past history of the genetic series. When these factors are associated into a homogeneous complex, the resulting type of organization is such as we see in a tissue whose numerous cells are alike in histological differentiation. The shaping of tissues into organs implies a precisely corresponding departure from homogeneity in the complex of factors concerned. The modification or disappearance of any one or several of these factors is not necessarily followed by loss of organization, but only by change in the relations which constitute organization.

The second alternative, while admitting that organization must involve a multiplicity of factors, asserts that amongst these is one factor, or a group of factors, of dominant importance. This dominant factor may conceivably determine structural uniformity and concerted action even when the other factors affecting the system constitute a complex which is not exactly homogeneous. Upon the other hand, we can imagine that the operation of a localized dominant factor in a system otherwise marked by perfect homogeneity of conditions produces the differentiation of a portion of that system into a system of higher order, as when a region of a germ-layer is modified into an embryonic organ. With the removal of the dominant agent, all other factors remaining the same, organization of a certain grade completely disappears, although organizations of lower order may remain. A case which conceivably may prove to be an illustration of this hypothesis is afforded by the headless fragment of worm which, while remaining alive for a considerable time, does not regenerate. The living fragment exhibits organizations of the various grades corre-

sponding to organs, tissues and cells. But the agent which dominates these lower organizations and produces the organization into a whole individual has somehow disappeared.

The first view we may conveniently designate as the theory of autonomous elements, understanding that this autonomy does not preclude the possibility that the environment in which each element lives may depend in a great variety of ways upon the operation of other systems. The second view we may call the theory of controlled elements or the theory of dominance, referring to the existence of specific agents which dominate and coordinate the form and behavior of structural elements.

The problem of organization in the form in which I have here stated it has no definite relation to that problem of ontogeny whose alternative and opposed answers have from time to time and with ever shifting significances borne the names preformation (or evolution) and epigenesis. The theory of autonomous elements associates itself very consistently with the idea of a considerable degree of rigid germinal preformation—mosaic development. Nevertheless, a scheme of development which is to the fullest possible extent epigenetic may be thought of as depending essentially upon the ever-changing environment of each individual element, the orderly series of successively determined stages proceeding in the total absence of specific form-determining agents exercising immediate control over groups of elements. The theory of dominance may likewise be consistently linked with either conception of the mode of development. Let it be assumed that the harmonious operation of any ontogenetic system, such as the concerted action of the entoderm cells in gastrulation, be due to the presence of an agent which coerces the elements of the system into that particular form of behavior, even in spite of some differences which may exist amongst those elements and in spite of some degree of inequality in their several environments—an agent in whose absence there would be no concerted action at all. We then have our choice of these two alternatives. We may attribute the existence and timely operation of the control agent directly to some peculiarity of the germ—preformation; or we may suppose it to arise as a function of the preceding stages in development, being thus only indirectly related to the original germ organization—the epigenetic view.

Neither does the line between our two conceptions of the nature of organization coincide with the line separating those two groups of theories known as mechanistic and vitalistic. This statement can the more confidently be made in view of the fact that there is serious disagreement as to where the latter line really lies. The theory of autonomous elements leads almost necessarily to a mechanistic view of the organism. Factors which are in any sense to be regarded as vitalistic could scarcely be introduced save by actual violence. The theory of dominance, however, affords ample latitude for the extremes of these two groups of opposed philosophical attitudes. If it is possible to imagine that the harmonious action of a system is the resultant effect of the coincident operation of the mechanisms of its autonomous elements, it is equally possible to imagine that mechanisms have arisen on a larger scale, not confined within the limits of a single element, but embracing groups of elements. To think of such a larger mechanism operating through or by means of the elements embraced within its scope, or operating within the substance of a group of elements irrespective of its subdivision into elements, gives us the picture of a

system whose harmonious operation depends upon an agent which dominates all the elements or all the substance within the system. The lesser mechanism of the autonomous element in the one hypothesis and the greater control mechanism of the other hypothesis may equally well be regarded, if one is philosophically so disposed, as being the marvelous outcome of the accidental conspiracy between molecular structure and a selectively acting environment. Upon the other hand, a living being in which extensive groups of elements, physically more or less distinct and even heterogeneous in character, are in a large way dominated by agents which mold form and direct action, offers to the vitalist, of whatever type, a realm in which nonphysical, ultra-physical or psychic factors and forces may be created and set going to the limit of his bent.

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(*To be concluded*)

THE GROWTH OF CHILDREN

PREVIOUS investigations have shown that the rate of growth of the body, measured by weight and stature, increases very rapidly until the fifth month of fetal life. From that time on the rate of growth decreases, first rapidly, then more slowly until about four years before the age of puberty. During adolescence the rate of growth is considerably accelerated, and decreases again rapidly after sexual maturity has been reached. Thus the curve of growth represents a line which possesses a very high maximum at about the fifth month of fetal life. It decreases rapidly, and has a second, although much lower maximum shortly before sexual maturity is reached, and not long afterwards reaches the zero point.

The bulk of the body of girls and boys is approximately equal until the period of adolescence. Since this sets in much earlier in the female than in the male, the concomitant acceleration also sets in at an earlier time, with the result that for a few years girls are larger than boys.

The periods of most active growth of the various parts of the body differ considerably. Nevertheless, it would seem that the characteristics of the curve of growth as here outlined are repeated in many if not in all organs and parts of the body. For instance, although the head reaches nearly its full size at an early time, so that its rate of growth shows a much more rapid decrease with age than that of the bulk of the body, there is a slight acceleration of growth during the period of adolescence.

It might seem, judging from the data just mentioned, that the difference between the sexes does not develop until the period of adolescence; but a study of the eruption of the teeth which I made a number of years ago, and the more recent interesting investigations by Rotch and Pryor on the ossification of the carpus, show that the difference in physiological development between the two sexes begins at a very early time, and that in the fifth year it has already reached a value of more than a year and a half.

I give here a tabular statement of the available observations:

	Age in Years		Difference
	Boys	Girls	
Ossification of scaphoid	5.8	4.2	−1.6
Ossification of trapezoid	6.2	4.2	−2.0
Eruption of inner permanent incisors	7.5	7.0	−0.5
Eruption of outer permanent incisors	9.5	8.9	−0.6
Eruption of bicuspids	9.8	9.0	−0.8
Minimum increase of annual growth	10.3	8.2	−2.1
Eruption of canines	11.2	11.3	+0.1
Maximum increase of annual growth	13.2	11.2	−2.0
Eruption of second molars	13.2	12.8	−0.4
Maximum variability of stature	14.8	12.4	−2.4

These data are not very accurate and must be considered a first approximation only.

When we remember that growth depends upon physiological development, it will be recognized that we must not compare the stature of girls of a certain age with that of boys of the same age, but that from the fourth year on a girl of a certain age should be com-

pared with a boy a year and a half older than she is.

If this view is correct, then it appears that the relation in size of the two sexes persists even in childhood.

I think no better proof can be given of the correctness of this view than the peculiar behavior of those parts of the body which complete their growth at a very early time; for instance, that of the head. The total amount of the growth of the head from the second year on is very slight. If, therefore, girls are ahead of boys in their development by about a year and a half or two years, the total amount of growth of the head in their favor will be the small amount of growth accomplished during this period of a year and a half or two years. If, then, there is a typical difference between the size of the body of male and female in childhood of the same character as found in adult life, then the head of the girl ought to be at all periods smaller than the head of the boy; and this is what actually happens. The phenomenon has been interpreted as indicating a less favorable development of the head of the woman; but the previous remarks show that it is obviously due solely to the different rate of physiological development of the two sexes. The results of psychological tests which show very generally that girls do better than boys of the same age, may be another expression of the general acceleration of their development.

Based on these observations, we may speak of a curve of growth and development of the whole body and its organs which has characteristic values for each sex and for each moment in the life of the totality of individuals that compose a social group. Not each individual, however, passes through these stages of development with equal rapidity. The mean square variability of the chronological age at which a certain point in the physiological development of an individual is reached is contained in the following table:

Age	Observations	Variability
0.0	Pregnancy	± 0.04
0.6	First incisors	± 0.21
1.6	First molars	± 0.31
4.2	Ossification of scaphoid bone, girls	± 1.4
4.2	Ossification of trapezoid bone, girls	± 1.2
5.8	Ossification of scaphoid bone, boys	± 1.1
6.2	Ossification of trapezoid bone, boys	± 1.3
7.0	Inner permanent incisors, girls	± 1.6
7.5	Inner permanent incisors, boys	± 1.4
8.9	Outer permanent incisors, girls	± 2.1
9.0	Bicuspids, girls	± 2.8
9.5	Outer permanent incisors, boys	± 2.1
9.8	Bicuspids, boys	± 1.6
11.2	Permanent canines, boys	± 1.4
11.3	Permanent canines, girls	± 1.0
12.7	Beginning of pubescence, boys	± 1.6
12.8	Second molars, girls	± 1.6
13.2	Second molars, boys	± 2.0
14.6	Completed pubescence, boys	± 1.1
14.9	Puberty, girls	± 2.0
19.3	Wisdom teeth, boys	± 2.1
22.0	Wisdom teeth, girls	± 1.8
35.0	Preauricular wrinkles	± 6.6
36.5	Hair on tragus	± 8.3
44.5	Menopause	± 5.3
62.5	Death due to arterial diseases, men	±13.2

It appears from this table, which may be represented in the form of a curve, that the variability of the physiological stages of development increases very rapidly—roughly speaking, so that its logarithm is about proportional to the actual age, or, to use the term applied by Dr. Crampton and Professor Rotch, to the "chronological age." The causes that lead to this rapidly increasing variability are so far entirely unknown. It is certain, however, that there must be definite causes at work which bring about this phenomenon; for, if the variability were due to accidental causes only, it would increase considerably slower than in a ratio proportional to the increasing age. The study of the general curve indicating the increase of variability in physiological development indicates an irregularity at the time of approaching maturity. At this period the variability seems to increase at an unusually rapid rate, and either to be stationary or to decrease again at a later time.

I have spoken here of the variability of the physiological development of the body as though this were a unit. In 1895, in a dis-

cussion of Professor Porter's observations on the growth of school children in St. Louis, I pointed out the fact that a general variability in physiological development accounts for the close correlation between the distribution of ages in school grades and the size of the body and its organs; and this problem was later on worked out by myself in conjunction with Dr. Clark Wissler in regard to various measurements. These correlations have also been proved in a most interesting manner by Dr. Crampton's observations on pubescence, and by Professor Rotch's and Pryor's study of the development of the epiphyses and carpal bones. It is true that a close correlation between the status of the physiological development of the various parts of the body exists, but there exists also a certain amount of variability in the development of an organ when another one has reached a definite stage. The correlation is so close that the condition of the bones or that of pubescence gives us a better insight into the physiological development of the individual than his actual, chronological age, and may therefore be advantageously used for the regulation of child labor and school entrance, as Rotch and Crampton advocate; but we must not commit the error of identifying physiological development with physiological age, or of considering chronological age as irrelevant. The clearest proof that is available is found in the data relating to increase of stature, and in observations on pubescence made according to Dr. Crampton's methods. Bowditch was the first to investigate the phenomena of growth of individuals who are short or tall at a given age, but his method was based on a statistical error. Later on I showed that retarded individuals possess a late acceleration of growth, and these results were amplified by studies made by Dr. Beyer and Dr. Wissler. Recently I had occasion to make a more detailed statistical analysis of the phenomena of growth, which show that individuals whose prepubertal accelerated growth begins late in life have rates of growth that exceed by far those of the normal individual; in other words, that among the retarded individuals the whole energy required for growth is expended in a very brief period. In the case of stature the phenomenon is complicated by the great differences in hereditary stature among the various parts of the population. It appears more clearly in observations on pubescence. The observations indicate that if the first pubic hair appears in one group of boys at eleven and a half years, in another at fifteen and a half years, it will take the former much longer than the latter to attain the full development of pubic hair, and the rate of change found among them will be much greater than that of normally developed individuals. Although further data are required to determine this point definitely, it is certain that we must not assume that individuals who exhibit the same stages of physiological development are the same, physiologically speaking, no matter what their actual age may be; on the contrary, the past and prospective physiological changes in their bodies will proceed in different manners. It is clear, therefore, that the greater the retardation or acceleration in any one particular respect, the greater will also be the disharmonies that develop in the body, since not all the other organs will follow the same rate of acceleration and retardation.

The causes of these phenomena are unknown; but we may perhaps venture on the hypothetical explanation that all the cells of the body undergo certain progressive changes with increasing age, and that the internal secretions which become active at the time of puberty exert a stimulus upon the cells which causes accelerated growth in the cells, and that the intensity of this influence depends also upon the state of development of these cells. This may refer to the whole body as well as to the glands that have a direct influence upon the rate of growth. In retarded individuals many of the cells have advanced in their development more nearly normally than the groups of cells involved in sexual maturity; and when their action sets in, the cells of the body are stimulated much more vigorously than the less developed ones of an individual that reaches maturity at an earlier time. This hypothesis, however, would have to be tested experimentally. It is intended only to bring

nearer to our understanding the complicated phenomena of retarded and accelerated growth.

It seems very likely that the abnormally large amount of energy expended upon rapid growth during a short period is an unfavorable element in the individual development. A study of the phenomena of growth of various groups of the same population has shown that early development is a concomitant of economic well-being, and that a characteristic of the poor is the general retardation in early childhood, and the later rapid growth. It follows from this that there is a corresponding, although not equal, retardation in early mental development, and a crowding of developmental processes later on, that probably place a considerable burden on the body and mind of the poor, which the well fed and cared for do not bear. The general laws of growth show also that a retardation kept up for an unduly long period can not be made up in the short period of rapid growth; so that it would seem that, on the whole, excessive retardation is an unfavorable element in the growth and development of the individual. Whether there are similar disadvantages in a considerable amount of early acceleration is not so clear.

Franz Boas

Columbia University

THE WORK DONE BY THE GERMAN SUBCOMMITTEE ON THE TEACHING OF MATHEMATICS[1]

I regret very much, that Mr. F. Klein, Göttingen, the president of the German subcommittee of the International Commission on the teaching of mathematics, is not able to come to Cambridge. It thus happens that I have the honor, in his place, of presenting to you the following short report of the present state of the work done in Germany.

When we consider the historical development of the German empire, it is very evident that we should not expect to find a homogeneous system of schools, controlled by a central board of education, as is usually the case in other countries. The various sections of the German people may be looked upon as different sources of the stream of German culture. Furthermore, the religious reformation tended to increase the variety of the German schools; for while in some parts of Germany the schools of to-day can be traced directly to the ancient cloister-schools, in other sections of the country there is not such a connection apparent. And finally the modern development of Germany from an agricultural state to an industrial one has also had a large influence on the formation of schools, so that a great difference in types must be expected and actually does exist.

A recognition of all these influences, the political, the religious and the economical, is essential to a complete understanding of German education, and they are therefore in evidence in the general plan of the German report as well as in the individual essays of which it consists.

The German report[2] is composed of 5 volumes, treating:

I. The secondary schools of northern Germany.

II. The secondary schools of southern and middle Germany.

III. Special problems of the secondary mathematical instruction.

IV. The mathematics at the technical schools.

V. The teaching of mathematics in elementary schools, and in the seminaries or training schools for elementary teachers.

These five volumes will comprise 36 individual reports and I have the honor to present 27 of them to the congress.

The German subcommittee has succeeded in engaging a staff of specialists in the various fields of mathematical instruction, and it has taken care to harmonize all the single reports with the general plan. The president, Mr. Klein, had the general supervision of all

[1] Report presented at the meeting of the Fifth International Congress of Mathematicians, at Cambridge (England), August 23, 1912.

[2] "Abhandlungen über den mathematischen Unterricht in Deutschland, veranlasst durch die Internationale Mathematische Unterrichtskommission," Herausgegeben von F. Klein, Leipzig, B. G. Teubner.

the volumes, being assisted by Mr. Lietzmann, the secretary of the German subcommittee. Furthermore, Mr. Klein gave special attention to the volumes I., III. and V., while the second volume was due in large measure to Mr. Treutlein, one of the most prominent of our secondary teachers, whose death, three weeks before this congress, is a great loss to our country. Volume IV., which relates to the mathematics at the technical schools, is largely in the hands of Mr. Staeckel.

At first sight it might be expected that the report would begin with the elementary schools, proceeding then to the secondary schools and finishing with the institutions of university rank. It is not possible, however, to give such a systematical description of the German schools. The variety is too great, the development of the different types of schools too peculiar, the mathematical instruction too varied, to make it possible to arrange our school-system in a straight line.

The points of view that have been set forth in the several papers can not be completely given in this short report. I may say, however, that in general there is given in every case a sketch of the historical development and of the organization of the special types of schools. Perhaps you will allow me to call especial attention to the fact that the reports of the German delegation not only present a fairly adequate picture of the mathematical instruction, but also of the whole German system of schools.

In order to set forth a general summary of the German reports, without entering into details, I beg to call attention to the third volume, which contains the discussion of certain general questions of the secondary mathematical instruction, and to mention in some detail the several papers.

During the last 10 or 20 years the reform of the teaching of mathematics has often been discussed not only in Germany, but in all cultivated countries. Therefore it is of interest that the first paper of the third volume is especially devoted to the development of these reform tendencies in Germany.

The second paper treats of the relation between mathematics and physics in the secondary schools, showing by numerous examples the great value of physics when founded on a high grade of modern mathematical instruction. We may assume that this paper will have a good reception in the native country and in the university of Newton.

The following three papers treat of applied mathematics, and especially of descriptive geometry, astronomy and practical arithmetic. These are followed by an essay on the history of mathematics as a means for raising the interest of the student in the subjects of the secondary school.

The last essay of the third volume that just appeared sets forth the relation between mathematics and philosophy. It shows us how the higher classes in mathematics in the secondary school receive a valuable training in philosophy as well. I am of the opinion that this paper will be found to contain much that will prove to be of value and of general interest to all readers.

Though all of the volumes of the German report treat more or less at length of the training of teachers, nevertheless it has been thought desirable to prepare a special paper on the study of mathematics at the German universities since 1870. I am sorry to say that this report is not yet printed, but it is just going to press. I need not urge the great importance of such a report, for it is evident that the education of teachers is the center of any substantial educational reform.

The reform of mathematical instruction is extending itself everywhere in Germany, and this tendency naturally leads, little by little, to a standardization of the instruction in the different parts of the country. But in spite of this tendency it must be said that, in matters of public education, Germany enjoys very great freedom. I dare say that this freedom is a notable characteristic of our country, and that there exists scarcely an analogy in any other of the leading countries of the world. I may illustrate this liberty of teachers and of the educational system by two examples: First, in Germany the teachers are merely obliged to follow certain general outlines

given by the minister of public instruction, without being slavishly bound to the text-books that are used in their schools; and second, the problems for the "Abiturientenexamen" (our finishing examination at secondary schools) are not prescribed by a central board or by the ministry, but are set by the teachers themselves, subject only to the approval of the authorities.

The reform in mathematical teaching is only one step in the reorganization of secondary education. This reorganization aims at making the youth of our country sympathetic with labor as well as appreciative of the best that is in modern culture. From this point of view the teaching of mathematics and science assumes a position equivalent to that in history and languages. It has been felt to be an important problem to reorganize the teaching of mathematics and science, and you are doubtless aware that the "Unterrichtskommission" of the German Association for the Advancement of Science, now enlarged to the "Deutscher Ausschuss für den mathematischen und naturwissenschaftlichen Unterricht," has prepared special outlines for the teaching of mathematics and physics as well as for that of biology. In presenting the German reports of the International Commission on the teaching of mathematics, I beg to be allowed to place here upon the table the publications of the Unterrichtskommission[3] and of the Deutscher Ausschuss[4] as far as they have been published until now.

A. Gutzmer

University of Halle

THE NINETEENTH INTERNATIONAL CONGRESS OF AMERICANISTS, 1914

In the fall of 1911 a number of delegates to the past congresses of the Americanists met in Washington, under the auspices of the Smithsonian Institution and the Anthropological Society of Washington, for the purpose of taking preliminary steps toward extending an invitation to the congress at its London meeting, to hold its nineteenth session in 1914 at Washington. A temporary organizing committee was selected, consisting of Professor W. H. Holmes, chairman; Mr. F. W. Hodge; and Dr. A. Hrdlička, secretary. This committee entered into communication with the principal local institutions and organizations which are interested in the work of the Americanists, and by May 1, 1912, a formal invitation to the congress was agreed upon by the Smithsonian Institution, the Anthropological Society of Washington, the George Washington, Georgetown and Catholic universities, and the Washington Society of the Archeological Institute of America. A list of names of persons to form the permanent organizing committee was agreed upon and Dr. Hrdlička was instructed to present the joint invitation with the list just mentioned to the council of the London meeting of the Americanists, which was done, and both were accepted without objection. In addition an official invitation from the Bolivian government was accepted for a second session, to be held at La Paz following that in Washington.

On October 11, 1912, the permanent committee for the Washington session met in the U. S. National Museum for organization. Its membership is as follows: Messrs. Franklin Adams, Frank Baker, Chas. H. Butler, Mitchell Carroll, Charles W. Currier, A. J. Donlon, J. Walter Fewkes, Alice C. Fletcher, Gilbert H. Grosvenor, F. W. Hodge, H. L. Hodgkins, William H. Holmes, Walter Hough, Aleš Hrdlička, Gaillard Hunt, J. F. Jameson, George M. Kober, D. S. Lamb, Chas. H. McCarthy, James Mooney, J. Dudley Morgan, Clarence F. Norment, Thomas J. Shahan, H. J. Shandelle, George R. Stetson, Chas. H. Stockton, J. R. Swanton, Harry Van Dyke, Charles D. Walcott and M. I. Weller.

The elections of officers resulted, in the main, as follows:

For Patron of the Congress: The President of the United States.

[3] A. Gutzmer, "Die Tätigkeit der Unterrichtskommission der Gesellschaft Deutscher Naturforscher und Aerzte," Leipzig, 1908, B. G. Teubner.

[4] "Schriften des Deutschen Ausschusses für den mathematischen und naturwissenschaftlichen Unterricht," Leipzig, Heft 1–14, B. G. Teubner.

President, Organizing Committee: W. H. Holmes, head curator, department of anthropology, U. S. National Museum.

Secretary: A. Hrdlička, curator, division physical anthropology, U. S. National Museum.

Auxiliary Resident Secretaries: Dr. Chas. W. Currier, Mr. F. Neumann.

Treasurer: C. F. Norment, president, The National Bank of Washington.

Head of General (honorary) Committee: Mr. Charles D. Walcott, secretary, Smithsonian Institution.

Head of Committee on Finance: Dr. George M. Kober, dean, Medical Department, Georgetown University.

Head of Committee on Arrangements and Entertainment: Professor Mitchell Carroll, general secretary, Archeological Institute of America.

Head of Committee on Printing and Publication: Mr. F. W. Hodge, ethnologist in charge of the Bureau of American Ethnology.

The sessions of the congress will be held, due to the courtesy of the authorities of the Smithsonian Institution, in the new building of the National Museum. The exact date for the meeting will be decided upon later, in accordance with the wishes of the majority of the delegates to the congress, but the month will, in all probability, be September. Active preparations for the session, which promises to be one of the most important ever held by the Americanists, will be begun without delay.

A. HRDLIČKA,
Secretary Committee of Organization

SCIENTIFIC NOTES AND NEWS

PRESIDENT TAFT has recommended to the congress that Colonel Goethals be appointed major general in the army as a recognition of his executive work in the construction of the Panama canal.

DR. REID HUNT, U. S. Public Health Service, has been appointed a member of the board created by the Bureau of Mines to study the hygiene and dangers in mines.

AT its last meeting the Rumford Committee of the American Academy of Arts and Sciences made the following appropriations: to G. W. Ritchey, of Pasadena, $500 for the construction of a reflecting telescope employing mirrors with new forms of curves; to Professor Edward L. Nichols, of Cornell University, $250 for the construction of a new form of electromagnet, to be used in an investigation by Mr. W. P. Roop, on the effect of temperature on the magnetic susceptibility of gases.

PROFESSOR L. A. CLINTON, who for the past ten years has been director of the Connecticut Agricultural Experiment Station at Storrs, has resigned and accepted a position with the Office of Farm Management of the U. S. Department of Agriculture. Professor Clinton's work with the department will be to have charge of the farm management investigations for the North Atlantic states.

PROFESSOR EDWARD M. FREEMAN, chief of the division of plant pathology and assistant dean and secretary of the faculty of the college of agriculture of the University of Minnesota, has declined the offer of the position of chief pathologist of the Kew Botanical Gardens. The position carries a salary of $4,700.

DR. G. R. KRAUS, professor of botany at Würzburg, has retired from active service.

MR. FRANK MEYER, agricultural explorer for the United States Department of Agriculture, will sail for China where he will conduct botanical exploration in the interior for the next three or four years.

MR. CHAS. WILSON and Mr. Arthur Henn, seniors in Indiana University, will sail on December 21 for Buenaventura, Colombia. They will explore Pacific slope streams and the Atrato river in continuation of the work of Professor C. H. Eigenmann on these streams between January and March of the present year.

THE fifth of the present course of Harvey Society lectures was given at the New York Academy of Medicine on December 14, by Professor F. B. Mallory, Harvard University, on "Infectious Lesions of the Blood Vessels."

PROFESSOR C.-E. A. WINSLOW, of the department of public health of the American Museum of Natural History and of the College of the City of New York, opened the first semi-

nar of a series conducted by the department of biology, Trinity College, on the evening of December 5.

Professor A. P. Carman, head of the department of physics of the University of Illinois, lectured on November 19, before the Central Association of Science Teachers at their meeting at Northwestern University.

At the first meeting for the year of the Oregon Academy of Sciences on November 30, Dr. William T. Foster, president of the academy, gave a brief opening address on "The Scope of the Academy and the Exact Sciences in Daily Life." Dr. Frank L. Griffin, professor of mathematics in Reed College, spoke on "The Ever-present Limit Concept," a discussion of higher mathematics in the common thought of to-day.

The Minnesota chapter of the Sigma Xi held the first of its scientific meetings on November 25. Two researches were presented: "The Enrichment of Sulphide Ores," by Professor William H. Emmons, and "The Scattering of Cathode Rays," by Dr. Louis W. McKeehan.

The Royal Geographical Society is taking steps to celebrate the Livingstone centenary on March 17, when Sir Harry Johnston is to give an address, and it is expected that Sir John Kirk, the only surviving companion of Livingstone on his expedition of 1858–64, will be present. The society is also arranging an exhibition of Livingstone relics, including autograph maps, Livingstone's sextant, compass, etc., with portraits and views and a section of the tree under which Livingstone's heart was buried, with the rude inscription carved by his native followers.

Edwin Smith, connected with the U. S. Coast and Geodetic Survey since 1870, known especially for his work on determinations of the force of gravity, died at Washington on December 2, aged sixty-one years.

Eben Jenks Loomis, for a half century (1850–1900) in the Nautical Almanac Office of the U. S. Navy Department, died on December 2 at Observatory House, Amherst, Mass., aged eighty-five years. Besides his technical work, he was a close student and observer of nature, discovering in 1877 a very remarkable flexing frond-movement of one of the lesser ferns growing about Washington, which at the time excited the keen interest of both Gray and Darwin.

Dr. William A. Buckhout, professor of botany and the senior professor at the Pennsylvania State College, died of heart disease on Tuesday, December 3, 1912. Dr. Buckhout was born in December, 1846, and was graduated from the Pennsylvania State College, in 1868. In 1871 he became professor of botany and horticulture in this college. In the changes brought about in agricultural sciences during recent years he became professor of botany. For many years he was botanist of the Pennsylvania State Board of Agriculture. In 1888 he was appointed to the Pennsylvania State Forestry Commission and was a prime mover in the state in creating and taking an active interest in forestry. He was a fellow of the American Association for the Advancement of Science. He was author of papers such as "The Chestnut as a Fruit and Food," "The Effect of Smoke and Gas on Vegetation," "A Microscopic Examination of State College Water Supply," "Forest Fires," and others, with annual reports as state botanist.

Dr. Edward Curtis, of New York, emeritus professor of materia medica and therapeutics in the College of Physicians and Surgeons of Columbia University, died on November 28, aged seventy-four years.

Dr. Elie de Cyon, formerly professor at the Academy of Sciences of St. Petersburg and the author of important contributions to physiology, has died, aged seventy years. He left Russia for political reasons and settled in Paris, where he devoted himself to literary work.

Mr. William Forsell Kirby, for many years a member of the zoological department of the British Museum (Natural History), the author of many publications on entomology, died on November 20, aged sixty-eight years.

DR. DAVID AXENFELD, professor of physiology at Perugia, has died at the age of sixty-four years.

MEMBERS of Section E, Geology and Geography, of the American Association for the Advancement of Science, are urged to send as soon as possible to Professor G. F. Kay, Iowa City, Iowa, the titles of papers to be read at the Cleveland meeting.

W. CAMERON FORBES, '92, governor-general of the Philippine Islands, has given to the Peabody Museum of American Archeology and Ethnology and to the Museum of Comparative Zoology some important collections of objects which illustrate life on those islands.

MR. AUSTEN CHAMBERLAIN has received £48,000 towards the £100,000 which he is raising for the London School of Tropical Medicine.

THE estimate of expenditure for the Bureau of Mines for the fiscal year beginning July 1, 1913, is as follows: for general expenses, \$70,240; for investigating mine accidents, \$347,900; for fuel investigations, \$135,000; for investigations into the treatment of ores and other mineral substances, \$250,000; for inspecting mines in Alaska, \$6,500; for books and publications, \$2,500; toward the erection of a suitable laboratory for the Bureau of Mines at Pittsburgh, \$115,000; for the collection of statistics concerning accidents in the mining industry, etc., \$25,000; for the purchase or lease of land for headquarters for mine safety cars, \$2,000. A total of \$954,140. The increases asked for include \$4,140 for general expenses, \$27,900 for investigating mine accidents, \$200,000 for investigations into the treatment of ores and other mineral substances, \$1,000 for the purchase of books and other publications, \$115,000 towards a new fire-proof laboratory and \$25,000, for the collection of statistics concerning accidents in the mining industry and other interests.

THE interesting region of the Arizona Petrified Forest was surveyed by the United States Geological Survey in 1910, and the resulting map has just been issued. The field work was done by Topographic Engineers Pearson Chapman and J. G. Staack, under the direction of R. B. Marshall, chief geographer. The area covered by this survey is known as the Petrified Forest quadrangle, and the map will be of especial interest and value to visitors to this remarkable region. It includes the principal portions of the Petrified Forest National Monument, a reservation created by executive order to protect these natural wonders against commercial vandalism, which was making serious inroads into the petrified specimens. The map shows the location and topography of six separate forests, including the famous Petrified Natural Bridge. The fossil trees of these forests are hundreds of thousands if not millions of years old, the wood of the trees having been submerged beneath a heavy covering of soil and then silicified and turned to stone. This stone is exceedingly hard; in fact, it is an agate, of many colors—red, yellow, purple, blue and intermediate shades—and is susceptible of a very high polish. The Petrified Forest is just south of the line of the Santa Fe Railway, in Navajo and Apache counties, Ariz., and is reached by wagon road from the town of Adamana. The map is sold by the director of the Geological Survey at a nominal price.

THE surface of the United States is being removed at the rate of thirteen ten-thousandths of an inch a year, or 1 inch in 760 years, according to the United States Geological Survey. Though this amount seems trivial when spread over the surface of the country, it becomes stupendous when considered as a total, for over 270,000,000 tons of dissolved matter and 513,000,000 tons of suspended matter are transported to tidewater every year by the streams of the United States. This total of 783,000,000 tons represents more than 350,000,000 cubic yards of rock substance, or 610,000,000 cubic yards of surface soil. If this erosive action had been concentrated upon the Isthmus of Panama at the time of American occupation, it would have excavated the prism for an 85-foot level canal in about 73 days. The amounts removed from different drainage basins show interesting comparisons. In respect to dissolved matter, the southern Pa-

cific basin heads the list with 177 tons per square mile per year, the northern Atlantic basin being next with 130 tons. The rate for the Hudson Bay basin, 28 tons, is lowest; that for the Colorado and western Gulf of Mexico basins is somewhat higher. The denudation estimates for the southern Atlantic basin correspond very closely to those for the entire United States. The amounts are generally lowest for streams in the arid and semiarid regions, because large areas there contribute little or nothing to the run-off. The southern Pacific basin is an important exception to this general rule, presumably because of the extensive practise of irrigation in that area. The amounts are highest in regions of high rainfall, though usually the waters in those sections are not so highly mineralized as the waters of streams in arid regions.

The first instalment of the vast works planned by Sir W. Willcocks for the irrigation of Mesopotamia by the storage of the Euphrates water is now nearing completion. Details as to the present position of the work, which is being carried out for the Turkish government by the engineering firm of Sir John Jackson, Limited, are quoted in the *Geographical Journal*. The part of the scheme first taken in hand has been the building of the great barrage at Hindieh, with associated works by which the water is to be distributed down the old branch of the river, past the site of Babylon, to Hilla. The barrage is being built to the east of the present bed of the Euphrates, and will be 250 meters long, with thirty-five arches fitted with sluice-gates. The piers of these arches are now completed up to the springing of the latter. This barrage will raise the level of the water by 7 meters, while a subsidiary barrage immediately below will provide for a further difference of 2½ meters. Adjoining the upper barrage there will be a lock for the use of the river traffic, while the lower barrage consists of a lock and a huge shelf of masonry. Work has also been begun on the Hilla regulator, a little above the barrage, which will consist of five arches. The excavation for this has been done, and the masonry begun. These works finished, an earthen dam will be thrown across the stream, which will thus be turned into its new bed between the barrage and the regulator. The old branch has been cleared out, and will be properly canalized, while at Habbania an escape is being constructed by which the flood-water will be carried off into the old Babylonian reservoir. It is estimated that 600,000 acres of land will be plentifully irrigated as a result of these works. The operations have involved a vast amount of excavation, concrete work, masonry, pitching, etc., but there has of late been a plentiful supply of local labor.

UNIVERSITY AND EDUCATIONAL NEWS

By the will of Mrs. Harriet D. Brown, who died in Worcester in November, the Worcester Polytechnic Institute receives a fund of some $50,000, the income to be used for scholarships.

Dr. John C. Hemmeter, professor of physiology at the University of Maryland, at the celebration of academic day on November 12 made a gift of $10,000 for the purpose of beginning the endowment of the chair for experimental physiology.

Mrs. A. M. Jones, widow of Professor Tom Jones, of Manchester, surgeon, who died on October 30, left £1,000 to the Victoria University, Manchester, in augmentation of the endowment of the Professor Tom Jones memorial scholarship, and £500 to the University College of Wales, Aberystwith, as an endowment for promoting the study of surgery.

Captain R. W. Silvester, for twenty years president of Maryland Agricultural College, has resigned because of impaired health. He has been made president emeritus and librarian of the institution. Professor Thomas H. Spence, vice-president of the college, has been appointed acting president.

Dr. Herbert J. Webber has resigned from the department of plant breeding of the College of Agriculture of Cornell University, to accept the directorship of the College of Agriculture of the University of California.

PROFESSOR C. F. BAKER, of the department of biology of Pomona College, has resigned to accept a professorship in the University of the Philippines. He will be at the College of Agriculture, Los Banos, Philippine Islands.

THE Coutts Trotter Studentship at Trinity College, Cambridge, founded for the promotion of original research in natural science (especially physiology and experimental physics), has been divided between Mr. E. D. Adrian, B.A., and Mr. A. E. Oxley, B.A.

THE council of the University of Paris has elected M. Andoyer, professor of physical astronomy in the faculty of science and member of the council of the Nice Observatory, as successor of the late M. Henri Poincaré in the professorship of mathematical astronomy.

DISCUSSION AND CORRESPONDENCE

INSECTS CONTRIBUTING TO THE CONTROL OF THE CHESTNUT BLIGHT DISEASE [1]

INVESTIGATIONS during the summer of 1912 by the Bureau of Entomology have brought to light some very important relations of insects to the chestnut blight, of which one of the most striking is that certain insects contribute to the natural control of the spread of the disease by feeding on and at the same time destroying the fruiting bodies.

During the winter of 1911 the writer observed many cankers with the pustules eaten out and the diseased bark infested with small larvæ. Later adults of the species were reared from these larvæ, one a Cerambycid, *Leptostylus macula* Say, the other a Colydid, *Synchita fuliginosa* Melsh; both were observed while caged to eat the pustules and stroma, the latter even to eat conidial threads.

At the Forest Insect Field Station 9, Charteroak, Pa., an extensive outbreak of the disease was found where a large percentage of the pustules were eaten. Investigation showed both species to be present but *L. macula* doing most of the work. Other insects collected and caged were found to eat the pustules as follows:

Family Buprestidæ—*Agrilus bilineatus* Web.
Family Chrysomelidæ—*Bassareus pretiosus* Melsh.
Family Trogositidæ—*Thymalus fulgidus* Er.

A number of experiments were made by Mr. R. D. Spencer, of the Chestnut Blight Commission, working with the writer, in culturing the stomach contents and excrement of *L. macula*, but in no case did the spores germinate.

Following these observations, a study of the chestnut throughout its northern range showed the same conditions everywhere the bark disease occurred. In many localities 50 per cent. to 75 per cent. of the pustules were eaten. In some cases scarcely a single perfect pustule could be found on a badly diseased tree and in such localities there was evidence of a marked decrease in new infection.

The fruiting bodies are eaten cleanly and deep into the bark, both pygnida and perithecia being destroyed. During the last summer a perceptible increase in the destruction of the pustules by insects was noticed. This shows that they have acquired a taste for the fungus which points toward increased destruction of the spores.

These insects, though not checking the growth of cankers already formed, play a most important part in controlling the dissemination of the disease.

F. C. CRAIGHEAD
BRANCH OF FOREST INSECTS,
BUREAU OF ENTOMOLOGY,
U. S. DEPARTMENT OF AGRICULTURE

[1] Read before the Biological Society of Washington, November 16, 1912.

A POSSIBLE CAUSE OF ACCIDENTS TO AVIATORS

TO THE EDITOR OF SCIENCE: I think that your valuable paper is in a position to render a very important service in aiding to lower the death rate among aviators.

Probably if we knew all the causes of disaster we should see that they are of many kinds.

To mention only one of the possible causes, take the gyroscopic effect of the revolving-cylinder motor.

Among your readers there are very many

physicists who collectively have a wealth of knowledge concerning gyroscopic action. Suppose that twenty or more of these were each to write an answer to the following question, suppose that the answers showed substantial agreement, would not their words come with great authority and lead to a thorough investigation of the subject?

The question which I propose for discussion is this:

Is it probable that the gyroscopic action of a revolving-cylinder engine produces dangerous stresses upon the framework of the flying-machine?

Practical airmen are not in agreement in this matter. Some say that the gyroscopic action is negligible, others say the contrary.

If physicists and others who have studied the gyroscope will kindly respond to this suggestion, I will see that marked copies of SCIENCE are sent to the editors of the leading aeronautical publications of the world.

JAMES MEANS

BOSTON,
November 22, 1912

THE PEDOMETER

TO THE EDITOR OF SCIENCE: In glancing over some pages of the Encyclopedia Britannica (eleventh edition) recently I found a short article on the *pedometer*, the concluding sentence of which is:

> Obviously the pedometer is little better than an ingenious toy, depending even for rough measurements on the uniformity of pace maintained throughout the journey measured.

Two definite statements are here made, both of which are quite erroneous. When properly understood and properly used the pedometer is a most useful addition to the outfit of a traveler and an especially delightful and comforting companion to those who know the joy of seeing the world *à piede*. A cheap instrument (costing only a dollar) which I have carried almost every hour of almost every day during the past dozen years is still "as good as ever," registering distances with an accuracy that is really surprising. It has been tested over hundreds of miles and kilometers of roadway in England, Germany, Italy and Switzerland (especially in the last-named country, where on most highways every kilometer of distance is marked by a stone monument), and found correct generally within one per cent., the error rarely being as much as two per cent. *I have known government surveys not so good.* Such an instrument can hardly be classed with "ingenious toys" and the explanation lies in the fact that the remainder of the sentence quoted above is equally erroneous. With the right sort of pedometer within certain considerable limits the record is *not* affected by variation in length of pace. There are two sorts of pedometers, the right sort and the wrong sort, and unfortunately it is the wrong sort that is usually offered for sale. This is simply a "step counter" the figures on the dial showing the number of steps taken and it is necessary to know the average length of step to convert this record into distance. Aside from the great inconvenience of being obliged to make a calculation whenever one desires to know the distance travelled even this instrument when properly adjusted and calibrated ought to give fairly satisfactory results. But the right sort of pedometer is not a pace counter and the numbers on the dial show directly the distance traversed in miles or, if one has the good fortune to live in a country where reason prevails over prejudice, in kilometers. In this the movement of the registering mechanism is caused by the rise and fall of a kind of horizontal pendulum, the length of the stroke for each step and hence the distance registered being capable of adjustment. But when short steps are taken the pendulum does not pass through the whole arc of its possible movement and the distance registered is consequently less. Thus, as stated above, the movement of the index hand is proportional to the distance traversed and, within certain limits, is not affected by variation in length of step. This is a most important fact and gives to this form of pedometer a value evidently not generally known or appreciated.

T. C. M.

RAVENNA, OHIO,
November 11, 1912

SCIENTIFIC BOOKS

The Physiology of Reproduction. By Dr. F. H. A. MARSHALL. Preface by Professor E. A. SCHÄFER, and contributions by Dr. W. CRAMER and Dr. J. LOCHHEAD. London, New York, Longmans, Green & Co. 1910. Pp. xvii + 706; 154 illustrations. Price $6.00 net.

Some branches of science are extensively intertwined with very many and very diverse branches of other sciences. The physiology of development is a notable example, since the data upon which it rests lie entangled in broad and widely different aspects of zoology and anatomy, obstetrics and gynecology, physiology and agriculture, anthropology and statistics.

Probably it is just this bewildering placement and variety of fact that has hitherto proved so effective a discouragement to authorship in this field. At any rate, the subject is here presented in a complete form for the first time. The physiology of nerve and muscle, of secretion and digestion, have long been systematically studied and the results have been many times brought together; too, studies in practical breeding, gametogenesis, and genetics have long been pursued, and the state of knowledge in each has been frequently epitomized. It is only very recently, however, that physiologists have begun to be impressed with the important relations which processes of reproduction bear to many other life processes; and only in the immediate present, in the field of heredity, is it becoming evident that the physiology of reproduction must help to solve many a problem heretofore attacked only from a very different standpoint. But, the breadth, vigor and thoroughness of Dr. Marshall's pioneering treatise are as satisfactory as the need of such a work was pressing.

Though the author has collected data of many kinds from very many different sources, his volume is much more than a digested abstract of the scattered literature; his own researches during several years on many of the important topics of reproduction have given the insight which alone can produce so unified and clear a volume.

Perhaps the greater number of pages of the work bear mostly upon the morphological side of the subject. This is probably both necessary and advantageous in the present state of the science. A solid structural basis is especially required where and when so many elemental questions are unsolved and still trembling in the balance. Chapters II., III. and IV., dealing with the œstrous cycle and changes in the ovary are notably of this character; largely morphological also are Chapters VII. and X. concerning the accessory reproductive organs of the male, and the placenta. The first chapter treats of the breeding season of animals; all of the invertebrate phyla being considered as well as the several classes of vertebrates. Other important chapters treat of the ovary and testis as organs of internal secretion, changes in the maternal organism during pregnancy, fertilization, lactation, fertility and the determination of sex. A rather too condensed but excellently written chapter on the biochemistry of the sexual organs will be welcomed by many. Besides other things it brings together for the first time most of the data now at hand on the new and promising subject of the energetics of development.

In many of these chapters the data and theories presented are criticized in the light of the author's own researches. In this way are presented some excellent treatments of such subjects as, the internal secretory function of the ovary and the testis; Mendelism; the influence of domestication, feeding, etc., upon the recurrence of the œstrous cycle and upon fecundity; fertility, and ovulation and the ovarian changes. We may note the point of view in only one or two of these cases. The internal secretions of the reproductive organs are attributed a scope and rôle not accorded by some recent investigators; and the connection between the ovary and uterus is considered as exclusively chemical, not nervous. Again, we note that the author is not led by the study of the physiology of reproduction to accept some of the important conceptions of Mendelism. "To the physiologist therefore a

so-called unit character can not readily be regarded as something located originally in a chromosome or chromomere. . . . It may be argued, therefore, in criticism of the Mendelian conception of unit characters, that it takes little or no account of the metabolism of the organism as a whole." How great a heresy to proceed from Cambridge! The book is indeed a mine, but the function of the reviewer can not be to extract the ore.

It is pleasing to find the volume dedicated to Mr. Walter Heape, to whom we owe so great a part of what is known of the physiology of the œstrous cycle, as well as much besides that is pertinent to this volume. More pleasing still is the style in which the whole work is written. In reading this volume one never tires, and there is little chance of getting lost. Adequate reference to an enormous literature and a comprehensive index add value to the book.

Dr. Marshall's pioneering treatise brings abundant help and inspiration to investigators within the several divisions of its field, and will ably and authoritatively serve the needs of the practical breeder and gynecologist.

Oscar Riddle

Methods of Organic Analysis. By Henry C. Sherman, Ph.D., Professor of Food Chemistry in Columbia University. Second edition. Rewritten and enlarged. New York, The Macmillan Co. 1912. $2.40 net.

The author has collected in this volume the methods of analysis of the more important organic compounds especially as applied to plant and vegetable substances and their manufactured products. They include such subjects as alcohols, aldehydes, sugars, oils, fats, waxes, soap, milk and preservatives. The best recognized methods have been selected and attention called to precautions necessary to secure satisfactory results.

One who wishes to know the best methods of analysis can not do better than consult this book, as the author has increased its value by adding, at the end of each chapter, a list of reference books and journal references for the past ten years. The use of this book by students would certainly give them practise in a considerable variety of analyses and make them capable of handling any ordinary problem presented.

J. E. G.

A College Text-book on Quantitative Analysis. By H. R. Moody, S.B. (M.I.T.), A.M., Ph.D. (Columbia), Associate Professor of Analytical and Applied Chemistry, College of the City of New York. New York, The Macmillan Co. 1912. 165 pages. $1.25 net.

This book, as the author states, is designed to be used by those who may be taking up quantitative work by themselves or with an instructor whose classes are too large to admit of much individual attention. It contains very explicit directions regarding every detail and is intended to make obvious the unnecessary pitfalls that consume time. For the purpose for which it is designed and for use in a brief course in a high school or college this book should be of great value in training the student in exact methods of procedure; but it seems too mechanical to put in the hands of a graduate student who is making a specialty of chemistry and is approaching the subject in a broad and comprehensive manner.

J. E. G.

Qualitative Organic Analysis. By F. B. Thole, B.Sc. (London), F.C.S., London University Exhibitioner in Chemistry, Lecturer in Organic Chemistry, East Ham Technical College, with an introduction by H. E. Dunstan, D.Sc. (London), Head of the Chemical Department, East Ham Technical College. London, Methuen & Co., Ltd.

In the introduction attention is called to the fact that "no royal road exists for the identification of an organic compound." The aim of this book is to afford a concise treatment of the subject on simple and logical lines, proceeding from the determination of the elements present in each case to the final characterization of the compound. The author has given a description of the common operations in practical organic chemistry, de-

termination of the melting and boiling points and preliminary tests for the elements present, before taking up the identification of the class and individual. These are clearly and concisely stated and should lead to the identification of the more important organic substances, provided the identification is substantiated by the preparation of the substance itself, without which no identification is really satisfactory.

J. E. G.

Notes on Qualitative Analysis. By HORACE G. BYERS, Professor of Chemistry, University of Washington, and HENRY G. KNIGHT, Director of Experiment Station, University of Wyoming. New York, D. Van Nostrand Co. 1912. $1.50 net.

We have here a further addition to the already too numerous volumes on qualitative analysis. The author has devoted, as we find to be the case in most of the recent books on this subject, the first fifty or so pages to a discussion of the physical-chemical principles of the subject before taking up the chemistry of the metals and their separation. The usual methods of analysis are used in most cases and at the end of each chapter questions of a general nature regarding the metals of that group and their compounds are added. One feature of the book which is to be specially commended, owing to the increasing use of special alloys, is the introduction of a chapter on the analysis of materials containing the so-called rare metals.

J. E. G.

Sociology in its Psychological Aspects. By CHARLES A. ELLWOOD, Ph.D., Professor of Sociology in the University of Missouri. New York and London, D. Appleton & Co. 1912. Pp. 402.

This is a thoughtful book, based on wide reading and careful scholarship. The large range of subjects with which it deals have all, at one time or another, attracted the serious attention not only of sociologists, but of many psychologists as well. The presentation of these subjects follows a logical order. The first six chapters are largely introductory. They discuss the conceptions, methods and problems of sociology and the relation of sociology to other sciences. Later chapters treat of the origin of society, social coordination, social self-control, the rôle of instinct, feeling, intellect, imitation and sympathy in the social life, the social mind and forms of association. The final topics are entitled social order, progress and the nature of society.

The chief unifying feature of the book is the author's conception of society. Society he defines as a group of individuals carrying on a collective life by means of mental interaction. In consequence the fundamental task of the sociologist becomes the study of the continuously changing coordinations or coadaptations of the activities of the members of groups and of the relations of groups to the environment. Sanctioned modes of coordinated activity become institutions. Systems of government, law, religion, morality and education, however, are not to be understood from the standpoint of any single mental element, such as instinct, imitation, sympathy, feeling, desire or intellect. Nor are they to be understood from the standpoint of any special science, such as geography, ethnology or economics. A synthetic view is necessary.

During the course of the book, Professor Ellwood views this central position from almost every conceivable abstract point of view. The terms society, sociology, the collective life process, the unit of investigation in sociology, social psychology, social coordination, intermental stimulation, instinctive association, social forces, social mind, social consciousness, social will, public opinion, social organization, social control and many others that have appeared in sociological articles or books during the past twenty years, are all defined with great care and considered in detail. The various meanings that have been read into them by those who invented them or who have used them most are discussed. The reader is told in clear language exactly how these meanings differ from each other and from Professor Ellwood's own conceptions.

The value of the work thus accomplished is

enhanced by frequent and exact citation of authorities.

Concerning the specific treatment of the large number of topics discussed by Professor Ellwood little can be said in a brief review. Concerning the adequacy of the book as a whole, however, a few words of comment may not be out of place. In the preface Professor Ellwood himself modestly refers to the volume as an introduction to the psychological theory of society. That this correctly characterizes it, however, is true only in the sense that every work that attempts to deal with so large a field must leave the major part of the task undone.

The chief thing, however, which Professor Ellwood leaves undone is to bring abstraction to the test of inductive verification and to make concrete application of theory to history and to current events. To require him to have thus tested and applied all the theories he discusses, however, would be to demand of him the completed results of the task which sociology is just beginning. The fault perhaps lies more with the present status of sociology than with Professor Ellwood. Nevertheless, in the present reviewer's opinion the author could have improved his book very greatly by condensation of abstract discussion, by more frequent appeal to fact and more frequent illustration of the practical value of theory in meeting the broad problems of public policy.

To have systematically reviewed in a single volume, however, the various positions taken by the most important writers on the long list of topics mentioned above is a service; to have done so with the insight and care shown by Professor Ellwood is an achievement.

A. A. TENNEY

COLUMBIA UNIVERSITY

A VOTE ON THE PRIORITY RULE BY THE AMERICAN SOCIETY OF ZOOLOGISTS, CENTRAL BRANCH

AT the April meeting of the Central Branch of the American Society of Zoologists at Urbana, the Committee on Nomenclature in its report to that body requested authority to ask from the membership of the Central Branch an expression of opinion on the following question: "Do you favor the strict (inflexible) application of the 'priority rule' as the latter is now interpreted by the International Commission on Nomenclature?"

This request was granted by the adoption of the report by the Central Branch on April 5, 1912.

The chairman of the committee then entered into correspondence with the other four members in order to reach an agreement as to the manner of taking such a ballot, and this correspondence was terminated just before the commencement season of 1912, too late for a satisfactory ballot to be taken during that collegiate year.

On September 20, 1912, a letter was addressed to each member of the Central Branch showing the authority under which the vote was taken, quoting the "priority rule" without comment and asking a prompt return of the enclosed ballot in an addressed and stamped envelope furnished with the vote.

Practically a month was given for the return of the ballots, and then the chairman of the committee requested the two nearest members to meet with him at Chicago on October 19 to open the ballots and decide on the form and medium of publication of the result of the vote.

The following members voted in favor of the strict (inflexible) application of the priority rule as now interpreted by the International Commission on Nomenclature:

J. F. Abbott, professor of zoology, Washington University.

C. H. Eigenmann, professor of zoology, Indiana University.

Harrison Garman, professor of entomology and zoology, Kentucky State University; and state entomologist.

Harold Heath, professor of invertebrate zoology, Stanford University.

S. J. Holmes, associate professor of zoology, University of California.

W. J. Moenkhaus, professor of physiology, Indiana University.

S. E. Meek, assistant curator of zoology, Field Museum of Natural History.

Wm. E. Ritter, director, Scripps Institution for Biological Research of the University of California; professor of zoology, University of California.

Alexander G. Ruthven, head curator, Museum of Natural History, University of Michigan.

Frank Smith, associate professor of zoology, University of Illinois.

Harry Beal Torrey, professor of biology, Reed College.

S. R. Williams, professor of zoology, Miami University.

Robert H. Wolcott, professor of zoology, University of Nebraska.

The following members voted against the strict (inflexible) application of the priority rule as now interpreted by the International Commission on Nomenclature:

C. R. Bardeen, professor of anatomy, University of Wisconsin.

E. A. Birge, dean, University of Wisconsin.

H. L. Bruner, professor of biology, Butler College.

C. M. Child, associate professor of zoology, University of Chicago.

W. C. Curtis, professor of zoology, University of Missouri.

S. A. Forbes, state entomologist of Illinois.

T. W. Galloway, professor of biology, Millikin University.

John G. Graham, professor of biology, University of Alabama.

M. F. Guyer, professor of zoology, University of Wisconsin.

C. Judson Herrick, professor of neurology, University of Chicago.

Gilbert L. Houser, professor of animal biology, State University of Iowa.

S. J. Hunter, professor of entomology, University of Kansas.

Lynds Jones, associate professor of animal ecology, Oberlin College.

Charles A. Kofoid, professor of zoology, University of California.

F. L. Landacre, professor of zoology and entomology, Ohio State University.

George Lefevre, professor of zoology, University of Missouri.

E. L. Mark, Hersey professor of anatomy and director of zoological laboratory, Harvard University.

Wm. S. Marshall, associate professor of entomology, University of Wisconsin.

C. E. McClung, professor of zoology, University of Pennsylvania.

Maynard M. Metcalf, professor of zoology, Oberlin College.

Henry F. Nachtrieb, professor of animal biology and head of department, University of Minnesota.

H. V. Neal, professor of biology, Knox College.

James A. Nelson, expert in agriculture, Bureau of Entomology.

C. C. Nutting, professor of zoology, State University of Iowa.

J. T. Patterson, adjunct professor of zoology, University of Texas.

Jacob Reighard, professor of zoology, University of Michigan.

Edward L. Rice, professor of zoology, Ohio Wesleyan University.

Oscar Riddle, research associate, Carnegie Institution.

John W. Scott, assistant professor of zoology, Kansas State Agricultural College.

V. E. Shelford, instructor in zoology, University of Chicago.

A. Franklin Shull, assistant professor of zoology, University of Michigan.

George Wagner, assistant professor of zoology, University of Wisconsin.

L. B. Walton, professor of biology, Kenyon College.

Henry B. Ward, professor of zoology, University of Illinois.

S. W. Williston, professor of paleontology, University of Chicago.

The following members returned their ballots unmarked; one of them without comment, and the other two with comments indicating that they declined to vote on the question:

W. J. Baumgartner, assistant professor and chairman of department of zoology, University of Kansas.

J. B. Johnston, professor of comparative neurology, University of Minnesota.

Frank A. Stromsten, assistant professor of animal biology, State University of Iowa.

SUMMARY

In favor of the strict (inflexible) interpretation of the "priority rule"	13
Against the strict (inflexible) interpretation of the "priority rule"	35
Total vote	48

It thus appears that slightly more than 73 per cent. of the members of the Central Branch of the American Society of Zoologists who voted on the priority rule are opposed to the strict (inflexible) application of the rule as now interpreted by the International Commission on Nomenclature.

ANALYSIS OF THE VOTE

The three members of the committee who opened the ballots think it of interest to present the following brief analysis of the vote, based on a division of the voters into classes of voters. The classification of voters is made on the concurrent judgment of the canvassers, and would probably vary somewhat had the selection been made by another committee. It is not likely, however, that the result of the analysis would be materially changed by any one having a somewhat wide acquaintance among the voters.

1st class.—Zoologists that may properly be called non-systematists.

Total number of voters in class	25
Number in favor of priority rule	3
Number opposed to priority rule	22
Majority against rule	88 per cent.

2d class.—Systematists in a broad sense. Including those who have had considerable experience in identifying species and some experience in naming and describing new species.

Total number of voters in class	23
Number in favor of priority rule	10
Number opposed to priority rule	13
Majority against rule	56½ per cent.

3d class.—Systematists in a strict sense. Including those who have done monographic work in systematic zoology; work that can be regarded as authoritative in its own field. This class is a selected group from the 2d class.

Total number of voters in class	7
Number in favor of priority rule	3
Number opposed to priority rule	4
Majority against rule	66⅔ per cent.

The number in this class is so small that it would probably be fair to conclude that the systematists in a strict sense are about equally divided in opinion regarding the priority rule.

REMARKS

A space on the ballot headed "Remarks" was utilized by twenty-one of those who voted. An attempt is made below to summarize these remarks:

"Remarks" on Ballots in Favor of Priority Rule

Three voters believed that the adherence to the rule would be best for future generations of zoologists.

One believes "in the establishment of authority by legislation and not in individual judgment."

One considers adherence to the rule "the only way out of the present confusion of tongues."

One, who votes for the rule, says:

> I am strongly in sympathy with what I understand to be the spirit of the "law of priority," but am certain that as it is being applied in the group of organisms with which I am particularly familiar it is producing results exactly the reverse of what, in the spirit of it, it is expected to produce; that is, it is adding to, not diminishing, confusion.

This is one of the voters of the 3d class, as defined above.

"Remarks" on Ballots Opposed to the Priority Rule

There were four who believed that it should be possible for a committee of experts to modify or make exceptions to the rule.

Four believed that names of long standing and general acceptance should be exempted from the application of the priority rule.

Two believed that a more flexible application of the rule would make for greater convenience. One says:

> Nomenclature is a tool, and serves its best purpose when it operates with the greatest convenience. It is certainly not convenient when a name known to everybody as applying definitely to a definite object is changed on the discovery that some long forgotten name has priority.

Another voter voices practically the same opinion.

One is opposed to the strict application of

the rule, but is also opposed to individual action in the matter.

One opposes the rule because "it [opposition to the rule] is the position occupied by practically all of the zoologists of the German Empire."

One votes in the negative because systematists in whom he has confidence complain of the working of the rule.

One, although opposed to the rule, is in favor of "some sound, workable set of rules."

There were two voters who declined to vote because they were not systematists and believed that they should have no voice in the matter.

In summing up it seems evident that an overwhelming majority of the zoologists of the Central Branch are opposed to the strict application of the priority rule; that a clear majority of systematists in a broad sense are opposed to it; and that at least half of the systematists in a strict sense are opposed to it.

The undersigned give it as their personal opinion that the wishes of the non-systematists, users of zoological names, should have *some* weight in the formulation of rules of nomenclature, as they will certainly have *much* weight in the acceptance of names and their incorporation into the general literature of the science of zoology.

C. C. NUTTING
S. W. WILLISTON
HENRY B. WARD

SPECIAL ARTICLES

FAT DEPOSITION IN THE TESTIS OF THE DOMESTIC FOWL [1]

VARIOUS investigators have concluded that the presence of fat in the interstitial tissues of the primary sexual organs (ovary and testis) was evidence of a functional (secretory) activity of the interstitial cells. This view regarding an internal secretion of the testis was advocated by Ganfini.[2] Whitehead,[3] while not committing himself definitely on the point, nevertheless shows that his earlier criticism of Ganfini's theory, on the ground that the fatty substance in the testis had not been shown to be anything other than ordinary neutral fat, was not altogether well taken. Schaeffer[4] makes the presence of fat, as revealed by staining, the chief test of functional interstitial glands in the ovary. One of the present writers in a recent paper from this laboratory[5] has shown that a histological study of the chicken testis gives "no evidence that the fat in the active testis is formed by the interstitial cells." It is further suggested in the same paper that "this fat is being brought to the testis by the general metabolic processes, possibly in connection with sexual activity, just as fat is deposited in the yolk of eggs in the hen."

It seemed desirable to test further, and by direct physiological experiment, this conclusion and suggestion. Particularly information was needed on the following points: (*a*) Is circulating fat deposited in the testis, as it is known to be in the yolk of developing oocytes? (*b*) If so, does such deposition depend in any way upon the functional sexual activity of the organ? (*c*) Is circulating fat deposited in the ovary prior to the time of rapid growth of the oocytes by yolk formation?

To obtain answers to these questions a series of experiments was planned by the writers and carried out last spring. The results are reported in this paper. It is known from the work of Riddle[6] and others that the

[1] Papers from the Biological Laboratory of the Maine Agricultural Experiment Station.

[2] Ganfini, C., "La struttura e lo sviluppo delle cellule interstiziale del testicolo," *Arch. ital. Anat. ed Embriol.*, Vol. I., 1902.

[3] Whitehead, R. H., "A Microchemical Study of the Fatty Bodies in the Interstitial Cells of the Testis," *Anat. Rec.*, Vol. 6, pp. 65–73, 1912.

[4] Schaeffer, Anna, "Vergleichend histologische Untersuchungen über die interstitielle Eierstocksdruse," *Arch. f. Gynäk.*, Bd. 94, pp. (of reprint) 1–51, Taf. XVII.

[5] Boring, A. M., "The Interstitial Cells and the Supposed Internal Secretion of the Chicken Testis," *Biol. Bul.*, Vol. XXIII., pp. 141–153, 1912.

[6] Riddle, O., "On the Formation, Significance and Chemistry of the White and Yellow Yolk of Ova," *Jour. Morph.*, Vol. 22, pp. 455–491, 1911.

fat stain Sudan III., if introduced into an animal *per os*, stains the fatty acids of the food, and that this stain is not lost during the circulation and deposition of these bodies. Furthermore, any fat *already* deposited in the tissues is not stained by Sudan III. fed in this way. This furnishes a method of observing the movement and deposition of fatty acids within the body. The original plan of the present experiments was to feed Sudan III. to chicks of both sexes at regular intervals from the time of hatching on, and then by examination of the testes and ovaries to determine at what stage of development the deposition of fat in the interstitial cells of these organs began, if it occurred at all. It was thought probable *a priori* that the beginning of active deposition would coincide with the beginning of the rapid growth of the sexual organs, which marks the onset of their functional activity.

This was found not to be the case. Experiments were begun with Barred Plymouth Rock chicks of both sexes, taken from the incubator as soon as they had dried off after hatching. To an equal number of individuals of each sex Sudan III. was given in each experiment. The dose was .02 gm. This was enclosed in a very small gelatine capsule, made by cutting down a regular No. 5. The chick's mouth was held open and the capsule carried down into the crop by means of fine forceps. A preliminary lubrication of the capsule in pure glycerine rather aided the administration. One male and one female in each experiment were not fed Sudan III., and these served as controls. In each experiment the total amount of Sudan III. fed was either .02 gm., .04 gm. or .06 gm., the ingestion of the larger amounts being spread over two or three days respectively. The maximum dose given in each twenty-four hours was .02 gm. Twenty-four hours after the ingestion of the last dose the birds were killed and the ovary, or testes, and samples of the body fat were removed and compared with the same organs and tissues taken from the controls. The result was that in all cases there was a distinct pink stain visible in the ovary or the testis of the birds fed the Sudan III. With the very small dose of .02 gm. the stain was faint, but with the large doses much more pronounced. This result shows that even with just-hatched chicks, in which the primary sex organs are certainly in a sexually non-functional condition, fat is being deposited in *both* testis and ovary.

The same result was obtained with chicks one week old. Sudan stained fatty acids were deposited in the primary sex organs. In view of these results there clearly was no point in continuing the experiments at regular intervals up to adult life. Consequently this was not done.

In order to test more fully the novel observation that metabolized fat is deposited in the *testis* an experiment in Sudan III. feeding was carried through with two adult males, one an adult male of the Golden Pencilled Hamburg breed, and the other a cross-bred male. These birds were in full sexual vigor, with large testes. The Sudan III. was fed as follows: The G.P.H. ♂, No. 2,494, was fed one capsule containing Sudan III. on each of four successive days. Each capsule contained .15 gm. of Sudan III. The other bird (No. 2,196) was fed three capsules (one per diem) successively. The amount of stain in each capsule was the same as before. The result of these experiments was exactly as before. There was an abundant deposition of pink stained fat in the interstitial tissue of the testes.

Putting all the facts together the following conclusions would appear to be justified:

1. A part of the metabolized fat from the food is carried directly to the primary sex organs (ovary and testis) and deposited in the interstitial tissues of those organs.

2. The amount of such deposited (and, in the subsequent chemical changes, probably elaborated) fat appears to be sufficient to account for the greater portion if not all of the fat which has been observed by histological methods in the interstitial tissues of the sex organs.

3. The deposition of fat in testis and ovary

as above set forth bears no apparent relation to the functional sexual activity of those organs, since it occurs from the time of hatching on. So far as the available histological or physiological evidence indicates, sexual activation of ovary and testis in the fowl begins at the earliest not until some weeks after hatching.

RAYMOND PEARL
ALICE M. BORING

A NOTE ON THE STAR-NOSED MOLE

TO THE EDITOR OF SCIENCE: On April 20 of this year I discovered a star-nosed mole (*Condylura cristata* (Linn.) Desmarest) entering a half-rotten willow stump at the edge of a little pond in the woods at West Roxbury, Mass. The crevice it had entered proved to be a *cul-de-sac*, and, after watching for some little time its eager efforts to escape by burrowing out, I easily captured it by seizing the tip of the tail between thumb and forefinger. I dropped it on the path close by, where it at once burrowed below the surface of the humus and progressed with some speed there, its progress being indicated by a lengthening ridge of earth. Catching it again, I carried it home wriggling and placed it in a wire cage with a wooden floor. It was very active but, owing, I suppose, to the position of the fore paws, which, of course, were fixed with palms outward, it could not get over the ground very rapidly. In the cage it kept going the rounds, poking its nose between the wires in an effort to escape. I dug some earthworms and placed them one by one in the cage. Apparently the mole's power of scent was nearly or quite as weak as its eyesight, for it paid no attention to the worms unless they were dropped directly in the path it pursued about the edge of the cage. When it actually ran its nose into a worm, however, it ate with astonishing greediness, and in a curiously piggish way, with a constant shaking of the head, and shuffling the worm into its mouth with the help of the *backs* of its "hands," which it moved in unison. It devoured about ten worms before its appetite appeared to flag, but one worm, a very large, fat one, it abandoned after cutting it into three pieces by transverse bites. Perhaps this worm was uncomfortably large for its mouth and gullet, for it afterwards ate one or two smaller ones. Little or no chewing took place, apparently, and the worm always disappeared down the animal's throat in a very short time. I heard no noise of the teeth in eating, such as Audubon and Bachman mention in describing the feeding of the common mole. A saucer of water put inside the cage, was not noticed for some time, but finally the mole put its nose into it and appeared to drink, with the same continual motion of the head that it used in eating. It tipped the saucer up a little and spilled some of the water, which it then seemed to drink off the board in a way that resembled sponging out the bottom of a boat. It continued the same operation on the dry part of the board, as if it could not tell where the water ended except by feeling. It struck me as a creature of very small intelligence. Its eagerness to escape was perhaps due less to fear than to a desire to get below the surface of the ground and to a habit of perpetual motion that seemed to possess it. I use the word "eagerness" advisedly, for that seemed to be the dominant mental attitude of the little animal. There was nothing frantic or nervous about its actions, simply eagerness to enjoy life, liberty and the pursuit of earthworms. The tail, and, in fact, the whole body, was very flexible and had a distinctly sneaky suggestion. This was especially noticeable as the animal climbed up and down the crevice in the stump. The mole escaped the same afternoon, so that my observations on its habits are not extensive, but certain mammalogists to whom I have told the story have advised me to put it on record in the pages of SCIENCE.

FRANCIS H. ALLEN

WEST ROXBURY, MASS.,
May 16, 1912

ECONOMIC IMPORTANCE OF THE MITE PHYLLOCOPTES SCHLECHTENDALI NALEPA

THE introduction of this mite into the pear and apple orchards of southern Oregon

(Rogue River Valley) has been comparatively recent. The writer found it for the first time in the summer of 1910, but it was thought to be of slight importance at that time and little attention was given it. Since that time, however, it has been very conspicuous in many pear orchards throughout the valley, and its effect upon the trees was so noticeable this season as to attract general attention.

It is interesting to note that Parrott[1] makes mention of it as very common on apple foliage in the United States, but does not seem to consider it a serious pest. However, he states that "*Epitrimerus pyri* and *Phyllocoptes schlechtendali* have been quite numerous and appear to be more common here than on the continent." However, he adds, "The behavior of these two species in the future is a matter of interest, as both seem to have possibilities of developing to greater economic importance." In SCIENCE (N. S., XXIII., 576) he states that *Phyllocoptes schlechtendali* has been detected only on apple foliage. However, the writer has noted that apple foliage is not seriously attacked, while the foliage, terminals of twigs, and frequently the fruits of the pear are most subject to injury. In fact, the presence of the mite on apple foliage seems to be of little importance, as no serious injury because of its presence has ever been observed.

In this district this mite seems to be of economic importance to the pear growers. The injury resulting from its presence in the pear orchards is generally apparent during the latter part of June or early July. The foliage has a peculiar rust or russet appearance on the under side and is also somewhat curled, as though by drought. There may be some slight russeting on the upper side, but this is rather uncommon. The terminals of shoots are also attacked and have the same brownish appearance of the under surface of the foliage. Where the attack is serious, the whole tree has a brownish appearance and the trouble has been given the local name "rusty leaf" by the fruit growers. During the latter part of July and through the month of August, badly injured trees shed the foliage from their terminals. The terminals have a somewhat shriveled appearance, the epidermis being brownish-black or black. Very often the injured epidermis is cracked or broken, due to the expansion of the growing tissue beneath. The fruit is also attacked and is russeted and cracked in the same manner as the terminals.

The injury to young pear trees is usually greater than to older bearing ones. Sometimes almost complete defoliation of the young tree results before it has had its season's growth, and besides the epidermis of the growing shoots has been injured. Fortunately, this mite is very easy to control. As in the case of all of our economic species attacking plants, the use of lime-sulphur, dry sulphur, oil emulsions, etc., will completely control it. Since it is a surface feeding mite producing no galls, it would seem that there should be no trouble in eradicating it.

The writer wishes to thank Dr. Nathan Banks, of the U. S. National Museum, for verifying his identification of the species.

P. J. O'GARA

OFFICE OF THE PATHOLOGIST
AND ENTOMOLOGIST,
MEDFORD, OREGON,
November 4, 1912

[1] Bulletin No. 283, New York Agricultural Experiment Station, 1906.

A PARAFFIN BATH WITH CONCEALED THERMO-ELECTRIC REGULATOR

ONE of the disadvantages about the ordinary paraffin bath is the exposed thermo-regulator. By attaching a covered moat to the back and one side of an oblong bath and inserting a thermo-electric regulator similar to one described by Long[1] patterned after Mast[2] there need be no delicate and breakable parts above the bath.

The bath described is heated by two incandescent lamps, one a four-candle, the other a

[1] Long, J. A., "The Living Eggs of Rats and Mice with a Description of Apparatus for Obtaining and Observing Them," Univ. of Cal. Pub. in Zool., Vol. 9, No. 3, pp. 105–136, pls. 13–17.

[2] Mast, S. O., 1907, "A Simple Electric Thermo-regulator," SCIENCE, N. S., 26, 554–556.

two. These are lighted constantly. Another four-candle lamp is connected with the regulator. These are placed in an asbestos-lined box beneath the bath. The whole apparatus surrounded with non-conducting material is packed in a box with a hinged cover. The only surface exposed when the box is opened is the top of the bath. Thick pads cover the moat, as it is lower than the top of the bath. This makes it possible to heat eight cups of paraffin, using at the same time less current than would be used by a single sixteen-candle incandescent lamp. Taking out from or putting into the regulator a small drop of mercury makes it possible to either raise or lower the temperature of the bath. Old lamps can be taken out and new ones put in through holes in the bottom of the box.

Such a bath has been in use more than a month, maintaining a temperature constant (54° C.) to within a fraction of a degree.

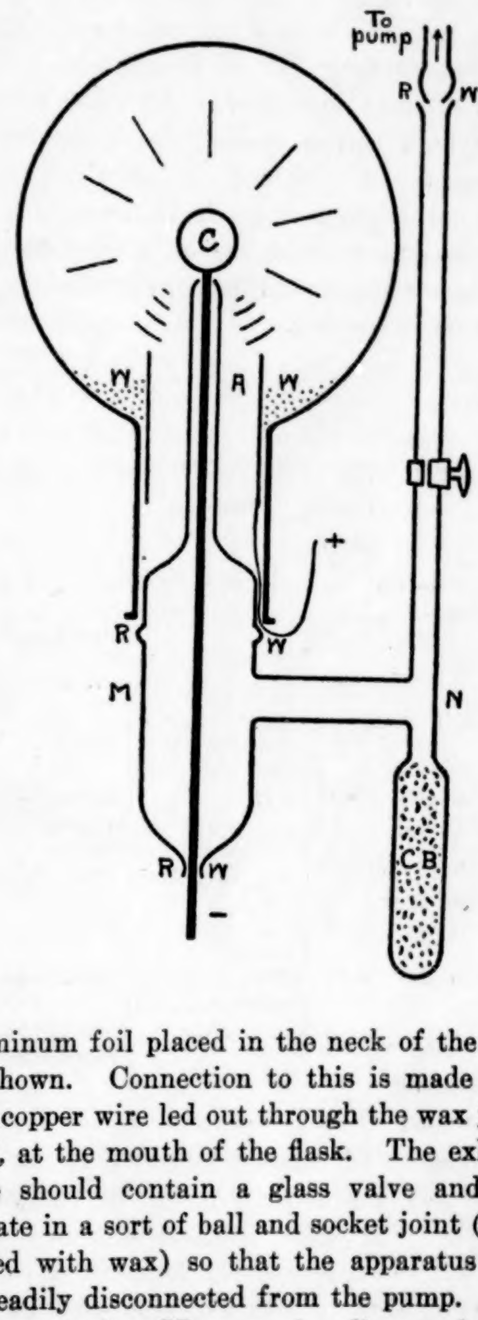
WEBSTER CHESTER

COLBY COLLEGE,
WATERVILLE, ME.

A SIMPLE DISCHARGE TUBE FOR DEMONSTRATION PURPOSES

AT the present time when so much interest is centered on electric discharge phenomena in evacuated tubes it may not be out of place to describe one of the discharge tubes that the writer used recently for class-room demonstration. The experiment is purely qualitative, and in principle contains nothing new. Its aim is to present with simple and easily constructed apparatus some of the phenomena that are usually given with more elaborate and expensive outfits. It does, however, require that the experimenter have access to, and be familiar with, the operation of an ordinary Geissler mercury pump and an induction coil. Aside from these the things needed are found in almost any laboratory and require no more skill to make than the blowing of a glass Tee.

The discharge tube in question is shown in the figure. The bulb may well be a two- or three-liter florence flask. The part to be blown is *MN*. It supports the aluminum rod carrying at its upper end the spherical or oblong cathode, *C*, of the same metal. The anode, *A*, is a cylinder of not too light weight



aluminum foil placed in the neck of the flask as shown. Connection to this is made by a fine copper wire led out through the wax joint, *RW*, at the mouth of the flask. The exhaust tube should contain a glass valve and terminate in a sort of ball and socket joint (to be sealed with wax) so that the apparatus may be readily disconnected from the pump. The charcoal bulb, *CB*, may be dispensed with where liquid air is not available. Liquid air is not a necessity; its use, as is well known, is to hasten the exhaustion. The three joints, *RW*, may be closed sufficiently air-tight by a good grade of red sealing wax.

The various steps, as the exhaustion proceeds, may be vividly shown—the stringy discharge, the Geissler stage, the formation of striæ, the Faraday dark space followed by

Crookes dark space, and finally the formation of cathode and X-rays. The phosphorescence due to the latter is strikingly shown by introducing into the bulb a few cubic centimeters of willemite flour (*W* in the figure). This should be well dusted over the inner surface of the bulb before sealing the apparatus to the pump. A particularly beautiful effect, at the cathode-ray stage, is to disconnect the pump and then shake the bulb vigorously so as to throw the flour through space while the discharge is passing.

Pressure in Mm. Hg	Induction Coil Discharge	Minimum D.C. in Volts Required to Glow Tube	Maximum D.C. Available Was 1,000 Volts	Remarks
2.0	Passed freely.	480		Blue at cathode.
1.5	More freely.	440	The dischage in each case was more voluminous than with the induction coil.	" " "
.5	Still more freely.	360		" " "
.08	Same.	360		Willemite began to phosphoresce.
.01	Less freely.	500	Discharge same as induction coil.	Willemite a beautiful green.
.006	Still less freely.	560	Less than induction coil.	Weaker.
.005	Small.	680	Much less than induction coil.	Still weaker.
.004	Faint.	—	No discharge.	Ceased to phosphoresce.
.003	None.	—	—	—

It may be of interest to add that the tube works well on direct current of fairly low voltage. For that purpose ordinary high potential storage cells (of capacity one tenth ampere normal discharge rate) may be employed. To guard against too great a current flowing through the discharge tube an adjustable water resistance should be included in the storage-battery discharge circuit. The effect upon the ease with which the storage battery discharge passes through the tube may be nicely shown by first ionizing the remaining gases in the tube by means of the high potential induction coil discharge, and then switching instantly to the storage cells. The minimum direct-current voltage that will, for a given pressure, produce a discharge may thus be obtained. This minimum voltage together with other data and remarks are given in the accompanying table.

Chas. T. Knipp

Laboratory of Physics,
University of Illinois

THE CONVOCATION WEEK MEETINGS OF SCIENTIFIC SOCIETIES

The American Association for the Advancement of Science and the national scientific societies named below will meet at Cleveland, Ohio, during convocation week, beginning on December 30, 1912.

American Association for the Advancement of Science.—President, Professor Edward C. Pickering, Harvard College Observatory; retiring president, Professor Charles E. Bessey, University of Nebraska; permanent secretary, Dr. L. O. Howard, Smithsonian Institution, Washington, D. C.; general secretary, Professor H. E. Summers, State College, Ames, Ia.; secretary of the council, Professor H. W. Springsteen, Western Reserve University, Cleveland, Ohio.

Section A—Mathematics and Astronomy.—Vice-president, Professor E. B. Van Vleck, University of Wisconsin; secretary, Professor George A. Miller, University of Illinois, Urbana, Ill.

Section B—Physics.—Vice-president, Professor Arthur Gordon Webster, Clark University; secretary, Dr. W. J. Humphreys, Mount Weather, Va.

Section C—Chemistry.—Vice-president, Professor W. Lash Miller, University of Toronto; secretary, Professor C. H. Herty, University of North Carolina, Chapel Hill, N. C.

Section D—Mechanical Science and Engineering.—Vice-president, Dr. J. A. Holmes, U. S. Reclamation Service; secretary, G. W. Bissell, Michigan Agricultural College, East Lansing, Mich.

Section E—Geology and Geography.—Vice-president, Professor James E. Todd, University of Kansas; secretary, Professor George F. Kay, University of Iowa.

Section F—Zoology.—Vice-president, Professor William A. Locy, Northwestern University; secretary, Professor Maurice A. Bigelow, Teachers College, Columbia University, New York City.

Section G—Botany.—Vice-president, Professor D. S. Johnson, The Johns Hopkins University;

secretary, Professor Henry G. Cowles, University of Chicago, Chicago, Ill.

Section H—Anthropology and Psychology.—Vice-president, Dr. J. Walter Fewkes, Bureau of American Ethnology; secretary, Professor George Grant MacCurdy, Yale University, New Haven, Conn.

Section I—Social and Economic Science.—Vice-president, John Hays Hammond, New York City; secretary, Seymour C. Loomis, 69 Church St., New Haven, Conn.

Section K—Physiology and Experimental Medicine.—Vice-president, Professor J. J. McCleod, Western Reserve University; secretary, Professor George T. Kemp, 8 West 25th St., Baltimore, Md.

Section L—Education.—Vice-president, Professor J. McKeen Cattell, Columbia University; secretary, Professor C. Riborg Mann, University of Chicago, Chicago, Ill.

The Astronomical and Astrophysical Society of America.—December 30–January 4. President, Professor E. C. Pickering, Harvard College Observatory; secretary, Professor Philip Fox, Dearborn Observatory, Evanston, Ill.

The American Mathematical Society.—December 31–January 2. President, Professor H. B. Fine, Princeton University; secretary, Professor F. N. Cole, 501 West 116th Street, New York City.

The American Federation of Teachers of the Mathematical and the Natural Sciences.—Between December 30–January 4. President, Professor C. R. Mann, University of Chicago; secretary, Eugene Randolph Smith, The Park School, Baltimore, Md.

The American Physical Society.—President, Professor W. F. Magie, Princeton University; secretary, Professor Ernest Merritt, Cornell University, Ithaca, N. Y.

The American Society of Biological Chemists.—December 30–January 1. President, Professor A. B. Macallum, University of Toronto; secretary, Professor A. N. Richards, University of Pennsylvania, Philadelphia, Pa.

The American Physiological Society.—December 30–January 1. President, Dr. S. J. Meltzer, Rockefeller Institute for Medical Research, New York City; secretary, Professor A. J. Carlson, University of Chicago, Chicago, Ill.

The Society for Pharmacology and Experimental Therapeutics.—December 30–31. President, Professor John J. Abel, The Johns Hopkins University; secretary, Dr. John Auer, Rockefeller Institute for Medical Research, New York City.

The American Society of Naturalists.—January 2. President, Professor E. G. Conklin, Princeton University; secretary, Professor A. L. Treadwell, Vassar College, Poughkeepsie, N. Y.

The American Society of Zoologists.—December 30–January 1. *Eastern Branch:* President, Dr. A. G. Meyer, Tortugas, Fla.; secretary, Professor J. H. Gerould, Dartmouth College. *Central Branch* (in charge of meeting): president, Professor H. B. Ward, University of Nebraska; secretary, Professor W. C. Curtis, University of Missouri, Columbia, Mo.

The Association of American Anatomists.—December 31–January 2. President, Professor Ross G. Harrison, Yale University; secretary, Professor G. Carl Huber, 1330 Hill Street, Ann Arbor, Mich.

The Entomological Society of America.—December 31–January 1. President, Professor Stephen A. Forbes, University of Illinois; secretary, Professor Alexander D. MacGillivray, 603 West Michigan Ave., Urbana, Ill.

The American Association of Economic Entomologists.—January 1–3. President, W. D. Hunter, Dallas, Tex.; secretary, A. F. Burgess, Melrose Highlands, Mass.

The American Microscopical Society.—December 31–January 1. President, Dr. F. D. Heald, Philadelphia; secretary, T. W. Galloway, Millikin University, Decatur, Ill.

The Botanical Society of America.—December 31–January 3. President, Professor L. R. Jones, University of Wisconsin; secretary, Dr. George T. Moore, Botanical Garden, St. Louis, Mo.

Botanists of the Central States.—Between December 30 and January 4. President, Professor T. H. Macbride, University of Iowa; secretary, Professor Henry C. Cowles, University of Chicago, Chicago, Ill.

The American Phytopathological Society.—December 31–January 3. President, Dr. G. P. Clinton, New Haven Agricultural Experiment Station; secretary, Dr. C. L. Shear, Department of Agriculture, Washington, D. C.

The American Nature-Study Society.—December 30–31. President, Professor Benjamin M. Davis, Miami University; secretary, Dr. Elliot R. Downing, University of Chicago, Chicago, Ill.

The Association of Official Seed Analysts.—January 2. President, Dr. E. H. Jenkins, New Haven,

Conn.; secretary, E. Brown, U. S. Department of Agriculture, Washington, D. C.

American Association of Official Horticultural Inspectors.—January 2–3. President, Dr. T. J. Headley, New Brunswick, N. J.; secretary, T. B. Symons, College Park, Md.

The American Anthropological Association.—December 30–January 3. President, Dr. J. Walter Fewkes, Bureau of Ethnology; secretary, Professor George Grant MacCurdy, Yale University, New Haven, Conn.

The American Folk-Lore Society.—January 1. President, John A. Lomax, University of Texas; secretary, Dr. Charles Peabody, Peabody Museum, Cambridge, Mass.

The American Psychological Association.—December 30–January 1. President, Professor Edward L. Thorndike, Columbia University; secretary, W. Van Dyke Bingham, Dartmouth College, Hanover, N. H.

The Sigma Xi Convention.—January 2. President, Professor Henry T. Eddy, University of Minnesota; secretary, Dr. Dayton C. Miller, Case School of Applied Science, Cleveland, Ohio.

Gamma Alpha Graduate Scientific Fraternity.—December 31. President, Professor William Crocker, University of Chicago; secretary, Professor H. E. Howe, Randolph-Macon College, Ashland, Va.

NEW HAVEN

The Geological Society of America.—December 28–31. President, Professor H. L. Fairchild, Rochester University; secretary, Dr. Edmund Otis Hovey, American Museum of Natural History, New York City.

The Association of American Geographers.—December 27–30. President, Professor Rollin D. Salisbury, University of Chicago; secretary, Professor Albert Perry Brigham, Hamilton, N. Y.

The Paleontological Society.—December 30–31. President, David White, U. S. Geological Survey; secretary, Dr. R. S. Bassler, U. S. National Museum, Washington, D. C.

BOSTON

The American Economic Association.—December 27–31. President, Professor Frank A. Fetter, Princeton University; secretary, Professor T. N. Carver, Harvard University, Cambridge, Mass.

The American Statistical Association.—December 27–30. President, Professor Walter F. Willcox, Cornell University; secretary, Carroll W. Doten, 491 Boylston Street, Boston, Mass.

The American Sociological Society.—December 27–31. President, Professor Albion W. Small, University of Chicago; secretary, Scott E. W. Bedford, University of Chicago, Chicago, Ill.

The American Association for Labor Legislation.—December 27–28. President, Professor Henry R. Seager, Columbia University; secretary, Dr. John B. Andrews, 131 East 23d St., New York City.

The American Home Economics Association.—December 30–31. President, Miss Isabel Bevier, University of Illinois; secretary, Benjamin R. Andrews, Teachers College, Columbia University, New York City.

NEW YORK CITY

The Society of American Bacteriologists.—December 31–January 2. President, Dr. Wm. H. Park, New York City; secretary, Charles E. Marshall, Amherst, Mass.

SOCIETIES AND ACADEMIES

PHILOSOPHICAL SOCIETY, UNIVERSITY OF VIRGINIA MATHEMATICAL AND SCIENTIFIC SECTION

The second meeting of the session 1912–13 of the Mathematical and Scientific Section was held October 22, 8:00 P.M.

Professor F. P. Dunnington read a paper on "The Grinding of Cornmeal for Bread." Professor Dunnington also made a report of Professor H. A. Bernthsen's method of making ammonia.

Dr. Graham Edgar presented reviews of Professor Samuel Eyde's paper on "The Oxidation of Atmospheric Nitrogen and the Development of Resulting Industries in Norway," and of Professor W. M. Perkin's paper on "Synthetic Rubber."

Wm. A. Kepner,
Secretary

University of Virginia

THE ELISHA MITCHELL SCIENTIFIC SOCIETY

At the 201st meeting of the society held November 12 in Chemistry Hall, University of North Carolina, the following papers were presented:

"The Physiological Action of Hæmatin," by Dr. W. H. Brown.

"Forestry for Eastern North Carolina Lumbermen," by Mr. J. S. Holmes.

James M. Bell,
Recording Secretary

Chapel Hill, N. C.